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FIELD MANUAL

TERMINAL OPERATIONS SPECIALIST'S HANDBOOK

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HEADQUARTERS, DEPARTMENT OF THE ARMY

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TERMINAL OPERATIONS SPECIALIST'S HANDBOOK

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PART ONE

CONVENTIONAL LOADING AND DISCHARGING AT FIXED FACILITIES

CHAPTER 1

GENERAL

1-1. Purpose and Scope

a. This manual is a guide for personnel concerned with the handling of military cargo in terminal operations. It deals with facilities, planning, operation, and equipment.

b. This manual consists of four parts:

(1) Part One provides general information on vessel data and characteristics, cargo planning, and loading and discharge of vessels through fixed wharf facilities.

(2) Part Two consists of general information on containers, equipment related to them, types of container movement systems, and operational requirements for such systems.

(3) Part Three contains instructions for loading and unloading vessels and moving cargo across the beach in logistics over-the-shore operations.

(4) Part Four gives instructions for loading and discharging rail and motor equipment. Loading, discharging, and transferring cargo at other than water terminals are also discussed.

c. This manual is applicable to nuclear and nonnuclear warfare.

d. Should metric measurements be required on

figures and dimensions expressed in this manual consult Appendix C, Conversion Factors.

1-2. Changes or Revision

Users of this publication are encouraged to recommend changes and submit comments for its improvement. Comments should be keyed to the specific page, paragraph, and line of the text in which the change is recommended. Reasons will be provided for each comment to insure understanding and complete evaluation. Comments should be prepared using DA Form 2028, Recommended Changes to Publications and Blank Forms, and forwarded direct to the Commandant, US Army Transportation School, ATTN: ATSP-CTD-OR, Fort Eustis, Virginia 23604.

1-3. Harbor Facilities

Personnel engaged in military stevedoring must be able to identify the facilities and structures alongside of which vessels are moored while cargo is being worked. Some of the terms used relating to harbor facilities or structures are described below and are illustrated in figure 1-1.

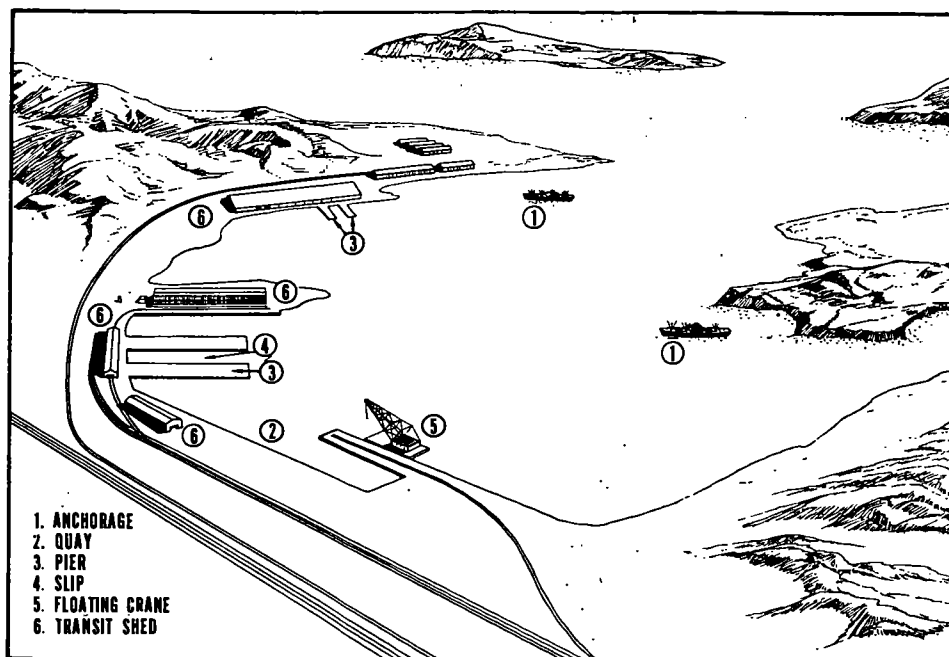


Figure 1-1. Nomenclature of harbor facilities.

a. Wharf. A wharf is a structure built alongside or extending into deep water with accommodations for securing vessels alongside it. Piers and quays are types of wharves.

(1) *Pier.* A pier is a wharf running at an angle with the shoreline and providing a landing place on each side for vessels to receive and discharge cargo or land passengers.

(2) *Quay.* A quay (pronounced "key") is a wharf constructed parallel to the shoreline; it has berthing accommodations on one side only.

b. Anchorage. An area in a harbor or stream where a vessel anchors or may anchor.

c. Berth. A berth is the area assigned to a vessel in port when anchored or when lying alongside a quay or a pier.

d. Slip. The area of water between two piers is known as a slip.

e. Transit Sheds. Transit sheds are structures built on piers or adjacent to quays for the temporary storage of cargo in transit between a vessel and an inland mode or storage area when covered protection is required. They may also be used for consolidating shipment units or for breaking bulk shipments.

f. Apron. An apron is that portion of a wharf, pier, or quay lying between the waterfront edge and the transit shed.

1-4. Types of Vessel Loading

The sequence in which cargo is loaded determines the sequence in which supplies and equipment will

be discharged. The cargo planner must be able to load a vessel so that it can be discharged to meet the requirements of any given mission. There are two general types of vessel loading: administrative and combat.

a. Administrative Loading. Administrative loading is a method of vessel loading giving primary consideration to achieving the maximum utilization of a ship's cargo carrying capability without regard to tactical considerations. In administrative loading, equipment and supplies must be discharged and sorted before they can be used. Since the majority of vessels are administratively loaded, this type of loading has been given primary emphasis in this manual. Cargo loaded administratively may be loaded for a single port or multiple ports of discharge.

(1) *Single-port loading.* In loading for a single port of discharge, the supplies are stowed so as to utilize the maximum carrying capacity of a ship.

(2) *Multiple-port loading.* In loading vessels for multiple-port discharge, supplies for more than one destination are stowed so that items can be discharged in the order of arrival at the ship's scheduled destinations. Care must be taken by the original and intermediate loading ports to prevent overstowing cargo for subsequent discharge.

b. Combat Loading. In combat loading, primary consideration is given to the facility with

which troops, equipment, and supplies can be unloaded ready for combat, rather than to economical utilization of vessel space. It is with this type of loading that cargo load planners are primarily concerned in amphibious operations. Information on methods of combat loading and methods of stowage for amphibious operations may be found in FM 60-30.

1-5. Terminal Organizations in the Continental United States

a. The Army is the single-service manager for surface transportation and for the operation of common-user ocean terminals in the continental United States (CONUS). The Military Traffic Management Command (MTMC) is the Army's organization for performing these functions. It commands and operates, or arranges for the use of, CONUS military common-user ocean terminals and obtains use of commercial ocean terminal capabilities when required to satisfy Department of Defense (DOD) export requirements.

b. MTMC provides a uniform organization that can function efficiently in peacetime and be expanded rapidly in an emergency with minimum disruption. The operations are accomplished through two categories of ocean cargo terminal operations: military ocean terminals and other ocean terminals.

(1) *Military ocean terminals.* These terminals are the gateway ports at Bayonne, New Jersey (MOTBY), on the Atlantic coast, and at Oakland, California (MOTBA), on the Pacific coast; these are, in fact, the largest ocean terminals in CONUS whose primary function is to provide interchange of DOD general cargo between land and water routes. Another military ocean terminal in operation is the Sunny Point Army Terminal (MOTSU) located at Southport, North Carolina. It is a special purpose port whose primary function is the shipment or receipt of ammunition and explosives.

(2) *Other ocean terminals.* This category covers terminal services at all ports other than those which have military ocean terminal facilities. These terminal services are concerned with directing and controlling the operation of common-user facilities at Navy tidewater depots, at outport operations managed by an MTMC activity providing terminal services through a commercial contractor rather than through a military operator, and with operating detachments as subactivities in port complexes where there is insufficient military traffic to warrant an outport or military ocean terminal organization.

For more details on CONUS military ocean terminal operations, see TM 55-606.

c. MTMC, the single managing agency for operating CONUS common-user ocean terminals, is responsible for providing berthing and docking services for vessels, having cargo available for loading at the specified time, preparing the stowage plan, and handling the cargo. These responsibilities include preparation of the hold for receiving cargo; stowing, lashing, and shoring as required; and cleaning the holds of Government-owned or Government-operated vessels after the cargo is discharged.

1-6. Terminal Organizations in Theaters of Operations

a. The transportation terminal group normally is the senior terminal activity in the theater of operation. When three or more groups are required, a terminal brigade may be assigned to the theater for command and coordination of the groups. The terminal group is primarily designed to command deepwater terminal activities. However, it can also command inland water terminals, Army air terminals, or any similar activities; normally, these activities are conducted in addition to or in conjunction with adjacent or related water terminal activities. The terminal group is a planning and control organization and does not enter into day-to-day operations.

b. In day-to-day operations, it is the terminal battalion that provides command, control, planning, and supervision of the attached operating units. It functions in essentially the same manner when employed over an extensive shoreline as in a small concentrated area, such as a conventional port installation. The commander of a terminal battalion is given a specific operational area and mission. To enable the terminal battalion to accomplish its assigned mission, the following type of units may be attached: terminal service units, boat units, amphibian and land transport units, and other units and equipment as required. Detailed information on the organization and operation of transportation terminal groups, battalions, and terminal service companies is contained in FM 55-60.

c. It is particularly important that the commander of the terminal which is making the last discharge of military cargo from the ship take every appropriate action to insure that all military cargo has been removed. These actions may include an inspection of all the cargo compartments of the vessel, including deep tanks, to

insure that no military cargo remains in stowage. This is crucially important when a ship is to leave the oversea theater.

1-7. Responsibilities of the Military Sealift Command as Vessel Operator

The Military Sealift Command (MSC) is the single agency designated to manage ocean transportation for DOD. It operates directly under the Chief of Naval Operations and provides, under one authority, for the control, operation, and administration of ocean transportation (excluding personnel and cargo transported by Navy fleet units) for all DOD departments and agencies. It provides vessels to transport cargo and personnel as required by the Army, the Air Force, and the Navy. MSC assumes responsibility for cargo when it is stowed on board and accepted by the master of the vessel. Responsibility terminates when the cargo is accepted and discharged at destination.

1-8. Relationship Between Ship's Officers and Army Transportation Personnel

a. Coordination between Army transportation

personnel and ship's officers is important in any stevedoring operation. Personnel in charge of stevedore operations aboard ship should immediately become acquainted with the ship's chief mate and captain. Many problems in handling, stowing, and securing cargo can be readily resolved by coordinating with the chief mate who is the ship's cargo officer.

b. In every case, the master of a vessel is completely responsible for the safe transportation of the cargo. He insures that the stowage will not adversely affect the safety or seaworthiness of his vessel.

c. Prestowage plans (para 2-17) are presented to MSC for approval. Upon arrival of the vessel, the plans are submitted to the master or his designated representative for approval, and the holds and ship's gear are inspected jointly to see whether there will be any difficulty in carrying out the loading according to the prestowage plan. If inspection reveals that the plan is not feasible, changes must then be made and approved by the master before cargo loading begins.

CHAPTER 2

PRESTOWAGE PLANNING

Section I. VESSEL DATA

2-1. General

Before planning the loading of cargo aboard vessels, the cargo planner should be familiar with the following:

- a. Classification system for vessel designs of the US Maritime Administration.
- b. Types of vessels used to transport passengers and cargo.
- c. Vessel tonnages.
- d. Vessel terms used in cargo planning.

2-2. Classification System for Designs of the US Maritime Administration

a. Maritime Administration vessels are classified by a system based on three groups of letters and numbers. The first group indicates the type of vessel, such as cargo, passenger, tanker, etc., and its approximate length. The second group indicates the type of propulsion, the number of propellers, and tells whether or not the vessel carries more than 12 passengers. The third group indicates the design of the vessel and any modifications to the basic design.

b. Tables 2-1 and 2-2 show the classification system. To illustrate how the system works, consider the vessel C4-S-1a.

(1) Table 2-1 shows that the C4 group covers cargo vessels with a length on the load waterline between 500 and 550 feet. Table 2-2 shows that the S means the vessel has a single propeller, is equipped with steam propulsion machinery, and carries no more than 12 passengers. Since there may be many vessels with these characteristics, an additional designation is necessary to identify the particular vessel's design. The designation of this vessel is 1a. The number 1 means this is the original construction of the 1a design. The lower case letter "a" indicates the original arrangement of this particular design.

(2) The vessel designation would be altered to reflect major changes such as accommodations for more passengers, conversion to troopship, etc. For example, suppose that accommodations for 50 passengers are added to this vessel. Since the passengers are still fewer than 100, the first group does not change; it remains C4. The second classification group becomes S1 to indicate that the vessel can carry more than 12 passengers. The third group becomes 1b to show that this is the first major change of this particular design. The vessel designation would become C4-S1-1b.

Table 2-1. Maritime Administration Classification System Classification Group 1—Type and Length of Ship

Type of ship	Length designation (load waterline in feet)*							
	1	2	3	4	5	6	7	8
C Cargo-Unltd service (under 100 pax)	Under 400	400-450	450-500	500-550	550-600	600-650	650-700	700-** 750
P Pax—Unltd service (100 pax and over)	Under 500	500-600	600-700	700-800	800-900	900-1000	1000 and over	
B Barge	Under 100	100-150	150-200	200-250	250-300	300 and over		
G Great Lakes cargo	Under 300	300-350	350-400	400-450	450-500	500-550	550- and over	
H Great Lakes pax	Under 300	300-350	350-400	400-450	450-500	500-550	550- and over	
J Inland cargo	Under 50	50-100	100-150	150-200	200-250	250-300	300 and over	
K Inland pax	Under 50	50-100	100-150	150-200	200-250	250-300	300 and over	
L Great Lakes tanker (ore, grain)	Under 400	400-450	450-500	500-550	550-600	600-650	650 and over	
N Coastwise cargo	Under 200	200-250	250-300	300-350	350-400	400-450	450 and over	
Q Coastwise pax	Under 200	200-250	250-300	300-350	350-400	400-450	450 and over	
R Refrig	Under 400	400-450	450-500	500-550	550- and over			
S Special***	Under 200	200-300	300-400	400-500	500-600	600-700	700 and over	
T Tanker	Under 450	450-500	500-550	550-600	600-650	650-700	700 and over	
U Ferries	Under 100	100-150	150-200	200-250	250-300	300-350	350 and over	
V Towing ships	Under 50	50-100	100-150	150-200	200 and over			
D Outside designs	This letter will be assigned to plans received from outside companies. If designs are developed from these for contracts, a design letter will be assigned.							

* Up to but excluding the upper limit of each interval.

** Longer vessels will continue to carry successive numerical sequences in 50-foot increments, i.e., C9-700-800, etc

*** This special designation will apply to certain Navy Department ships which may be built by the Maritime Administration and those of such a special nature that they fall outside of any of the other designations given in this table.

Table 2-2. Maritime Administration Classification System Classification Group 2—Type of Machinery and Number of Propellers and Passengers

Type of machinery	Propellers	12 Passengers and under *	Over 12 passengers **
Steam	Single	S	S1
Motor	Single	M	M1
Turboelectric	Single	SE	SEL
Diesel electric	Single	ME	MEL
Gas turbine	Single	G	G1
Gas turboelectric	Single	GE	GEL
Nuclear	Single	N	N1
Steam	Twin	ST	S2
Motor	Twin	MT	M2
Turboelectric	Twin	SET	SE2
Diesel electric	Twin	MET	ME2
Gas turbine	Twin	GT	G2
Gas turboelectric	Twin	GET	GE2
Nuclear	Twin	NT	N2
Steam	Stern wheel	SW	SO
Motor	Stern wheel	MW	MO

* Triple and quadruple screw add TR or Q respectively to single screw designation. Example: Triple screw motor ship is MTR
 ** Triple and quadruple screw and make digit 3 or 4 respectively.

2-3. General Types of Vessels

Vessels are classified generally according to the service for which they were designed—carrying passengers, cargo, or any combination of passengers and cargo.

a. *Passenger Vessels.* Passenger vessels are primarily designed to transport passengers (cabin or troop class), baggage, mail, and express or high priority cargo. They have limited cargo space. Loading and discharging cargo is difficult because of the small hatch openings.

b. *Cargo Vessels.* Cargo vessels are built to fit the transportation requirements of the trade, route, or service in which they are to be primarily engaged. As a result there are many types and classes, with some having accommodations for up to 12 passengers. There are two general types of cargo vessels: liquid cargo vessels (bulk tankers) which carry petroleum products, water, chemicals, molasses, and other liquids and dry cargo vessels which primarily transport all commodities not included in the liquid cargo classification.

c. *Combination Passenger and Cargo Vessels.* Combination passenger and cargo vessels have more cargo-carrying capacity than passenger liners. In addition to carrying a large number of passengers, they carry general cargo.

These vessels vary in passenger-cargo combination, speed, and size, depending upon the particular trade for which each vessel was built. Because of the cargo handling orientation of this manual, dry cargo vessels will be discussed further.

2-4. Types of Dry Cargo Vessels

Dry cargo vessels include general cargo (break-bulk, roll-on/roll-off, container ships, lighter aboard ship, and various combinations), bulk cargo, and reefer cargo vessels. Several models of the types with which the cargo handler or cargo planner may be concerned are described in this paragraph. This includes both a verbal and a pictorial description of major dry cargo vessel types (a through k, below) and a numerical comparison of their characteristics (table 2-3).

a. *Victory Ship (VC-2).* Victory ships (fig 2-1) were designed primarily to provide the post World War II merchant marine with a faster and more modern type vessel than the World War II Liberty Ship. The VC-2 has recently been replaced in the US flag privately owned merchant fleet by faster and more modern vessels. There are two classes of the Victory type, the AP2 and AP3 designs, differing only in speed and horsepower; the AP3 is the faster of the two ships.

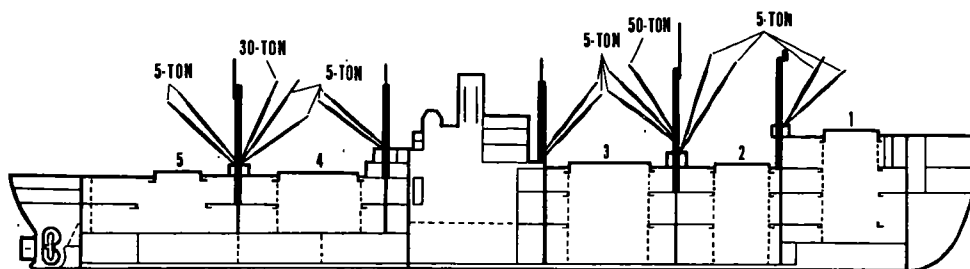


Figure 2-1. Victory ship (VC-2), profile.

b. *C1 Vessel.* There are three basic types of the C1 vessel: the C1A, C1B, and C1-M-AV1. The C1's are the smallest of the C class vessels, having approximately 18 percent less cargo space than the Victory. The C1-M-AV1 (fig 2-2) was

designed to meet the need for a coastal vessel. Reefers and tankers were also built for intercoastal operations using the same basic C1-M-AV1 design.

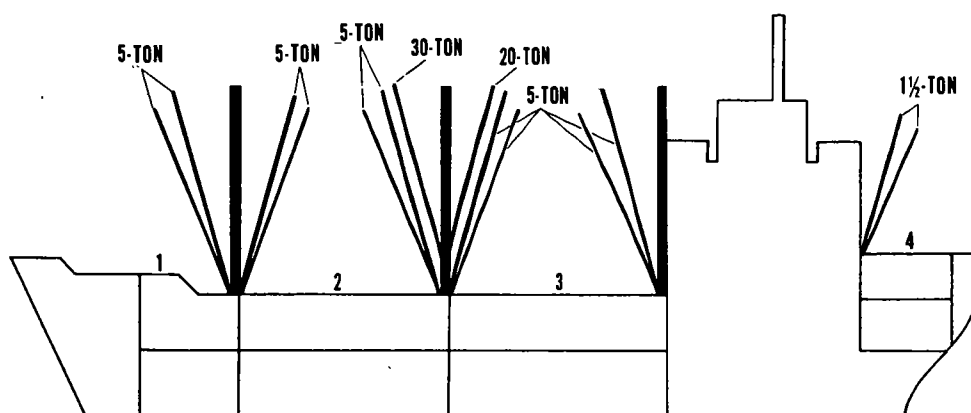


Figure 2-2. C1-M-AV1 vessel, profile.

c. *C2 Vessel.* The C2 vessel (fig 2-3) at one time was one of the most numerous of the C-types used for general cargo. There are several design

variations of this type, two of which are the C2-S-AJ1 and the C2-S-AJ3. These, like the Victory ship, are gradually being phased out.

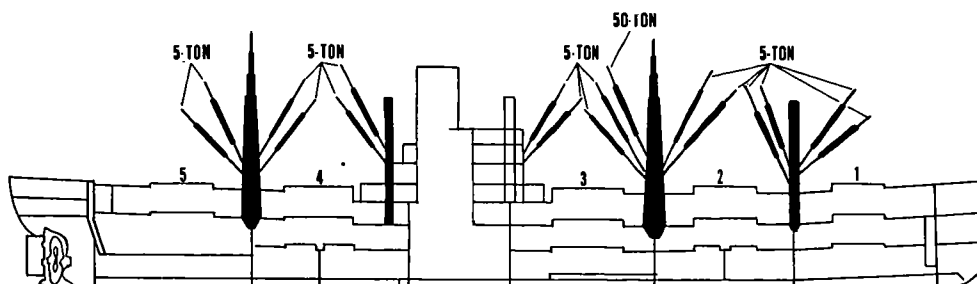


Figure 2-3. C2 vessel, profile.

d. *C3 Vessel.* The C3 cargo vessel (fig 2-4) is a type used extensively by US flag shipping companies. It has about 40 percent more cargo space than the C2 and can be used more

economically for large cargoes in worldwide trade. There are over 14 design modifications of this vessel. For a comparison of their characteristics, see table 2-3.

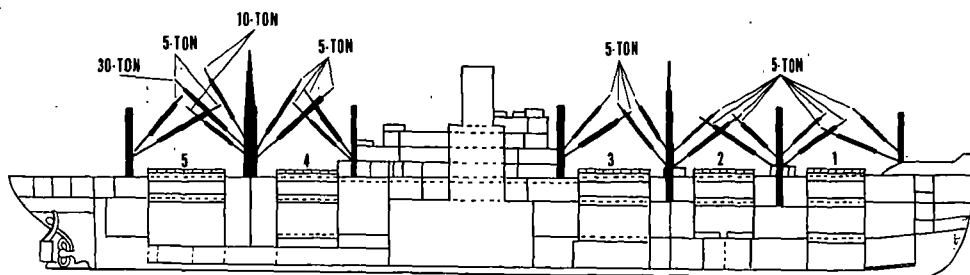


Figure 2-4. C3 vessel, profile.

e. C4 Vessel (fig 2-5). The C4 design vessel was the first cargo vessel able to obtain a 20-knot service speed. Many of the C4 vessels feature 10- and 15-ton general cargo booms at most hatches,

heavy-duty winches, power-operated topping guys, and hydraulically operated hatch covers at all deck levels. There are over 10 design modifications of the C4 vessel.

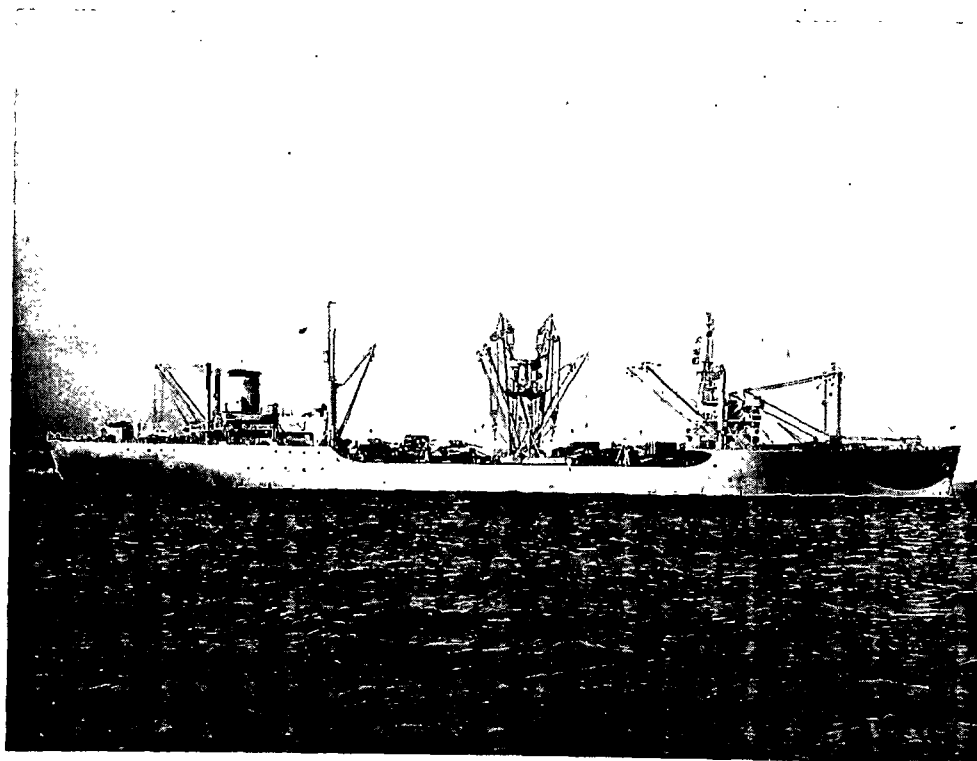


Figure 2-5. C4 vessel.

Table 2-3. Average Design Characteristics of Representative Maritime Administration Dry Cargo Vessels

Design	Length overall (LOA) (ft)	Draft loaded (ft)	Speed (knots)	Deadweight tonnage (LTon)	Gross tonnage	Average bale capacity (cu ft)	No. holds	Heavy lift capacity (STon)	No. containers (8x8x20)
VC-2	455	29	15.5-16.5	10,600	7,612	453,000	5	50	
C1-M-AV1	339	23	10.5	5,995	3,805	228,000	4	30	
C2									
C2-S-AJ1	459	28	15.5	10,775	8,258	543,000	5	50	
C2-S-AJ5	459	28	15.5	10,497	8,228	449,000	5	50	
C2-S-B1	459	27	15.5	10,500	6,132	546,000	5	30	
C2-S-E1	469	27	15.5	10,700	6,065	546,000	5	30	
C3									
C3-S-33a	483	31	18	12,402	9,252	425,000	5	75	
C3-S-37c	495	30	18	11,336	9,296	565,000	5	60	
C3-S-37a	495	30	17.4	10,948	9,218	549,000	5	60	
C3-S-37d	495	30	18	11,367	9,459	546,000	5	60	
C3-S-38a	493	28	18.5	10,967	7,849	575,000	6	50	
C3-S-43a	506	31	18	13,116	9,827	632,000	7	60	
C3-S-46a	493	31	18.5	12,629	10,659	663,000	6	60	
C3-S-76a	522	31	18.6	11,150	10,396	603,000	6	75	
C3-S-A1	492	29	16.5	12,343	7,950	672,000	5	30	
C3-S-A3	473	28	16.5	9,644	7,052	497,000	7	25	
C3-S-A4	492	29	16.5	12,005	7,924	536,000	5	30	
C3-S-A5	492	29	16.5	11,766	7,909	477,000	5	30	
C3-S-BH1	492	29	16.7	12,550	7,854	643,000	5	50	
C3-S-BH2	492	29	16.7	12,031	7,971	607,000	5	50	
C4									
C4-S-57a	561	32	21	13,535	11,105	572,000	6	70	
C4-S-58a	572	31	20	12,728	11,309	630,000	7	60	
C4-S-60a	551	31	21	12,763	10,484	577,000	6	75	
C4-S-64a	544	32	21	13,264	11,202	504,000	6	70	
C4-S-65a	560	30	20	12,699	9,322	480,000	7	80	
C4-S-66a	540	32	20	13,808	10,954	750,000	6	80	
C4-S-1a	564	30	20	13,498	9,214	736,000	7	60	
C4-S-1u	565	32	20	14,349	12,693	673,000	6	60	
C4-S-A4	523	33	17	14,714	10,684	629,000	7	50	
C4-S-B5	520	33	17	15,371	10,780	712,000	7	50	
C5									
C5-S-73b	610	31.6	20	14,600		975,840			928
C5-S-75a	605	35	20.8	22,208	15,949	1,018,000	7	70	409
C5-S-78a	601	34	23.6	15,694	11,757	1,194,000	7	70	800
C5-S-77	583	30	16.0	20,020	15,461	841,000			
C6									
C6-S-1w	661	30	20	16,590	11,100	1,047,000			
C7									
C7-S-68	701	32	22.5	20,574	18,876	1,335,000	10		1,210
C8									

Table 2-3. Average Design Characteristics of Representative Maritime Administration Dry Cargo Vessels—Continued.

Design	Length overall (LOA) (ft)	Draft loaded (ft)	Speed (knots)	Deadweight tonnage (LTon)	Gross tonnage	Average bale capacity (cu ft)	No. holds	Heavy lift capacity (STon)	No. containers (8x8x20)
C8-S-81a	820	35	22.5	18,850	26,400	1,125,000	6	446	356
C8-S-81b	820	35	22.5	18,850	26,400	1,125,000	6	446	(+ 49 lighters) 344
C8-S-82a	874	20	20	27,050					(+ 49 lighters) 1,600
OTHER					20,500	1,520,000			
RORO									
USNS									
COMET	499	27	18	10,545	12,750				
Callaghan	694	29	25	13,500	24,471	1,968,000	6	240	
Heavy-lift									
Seatrain									
Puerto Rico									
(Ex-T-2)	560	27	16.6	12,249	7,991	793,000	1	100	
Trans-Colorado									
(Ex-C-4)	523	32	17	11,475	10,014	601,000	5	240	
Multi-purpose dry cargo ships									
(Tentative)	650	28	21.6	29,958 (Total Displacement)		2,015,000		210	1,044

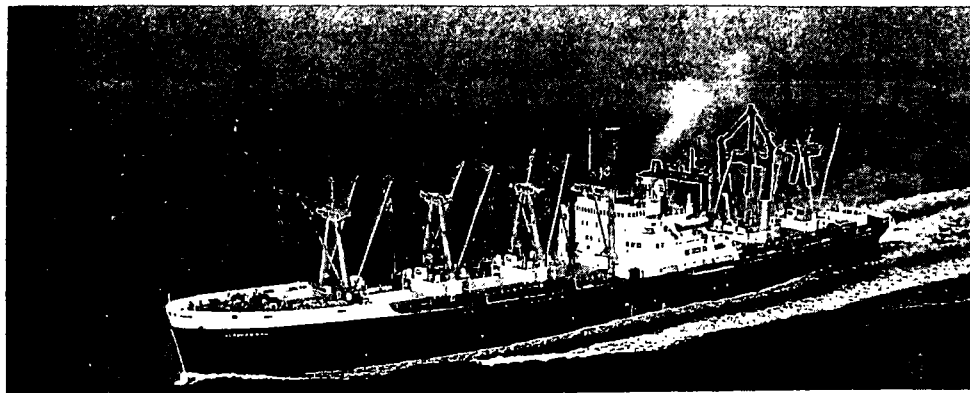
f. C5 Vessel. The development of the C5 design vessel brought to the US flag fleet one of the largest general cargo vessels in the world, the C5-S-75a, and a specially designed container/roll-on/roll-off combination vessel, the C5-S-78a.

(1) *C5-S-75a.* This vessel (fig 2-6(1) and (2)) is designed to carry bulk, break-bulk, and refrigerated cargo; 409 containers; and 2,377 tons of liquid cargo in its deep tanks. In addition to its

20-ton general cargo booms, hatches number 5 and number 6 are served by a new design, 70-ton (Newport News Rig) heavy lift boom. All hatch covers are hydraulically operated. Other distinguishing features of this vessel are the bipod of A-frame masts supporting the 20-ton general cargo booms. This design feature requires no shrouds or stays that might hamper cargo operations.

The C5-S-75a is a 26,000-ton vessel with a length of 210 feet, a beam of 32 feet, and a draft of 24 feet. It has a speed of 18 knots and a range of 10,000 miles. The vessel is designed to carry a variety of cargo, including bulk, break-bulk, and refrigerated cargo. It also has the capability to carry 409 containers and 2,377 tons of liquid cargo in its deep tanks.

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*Figure 2-6(2) . SS Alaskan Mail, C5-S-75a vessel.
(Courtesy of American Mail Lines, Ltd.)*

(2) *C5-S-78a*. This type C5 vessel (fig 2-7(1) and (2)), known as the Sea-Bridge class, can simultaneously roll cargo on and off the vessel through side-port and stern doors or lift it on and

off by cargo booms. With this versatility, the vessel can be loaded and unloaded in 1 day, as opposed to the usual 3 days for the C4 and lower classes, reducing in-port time considerably.

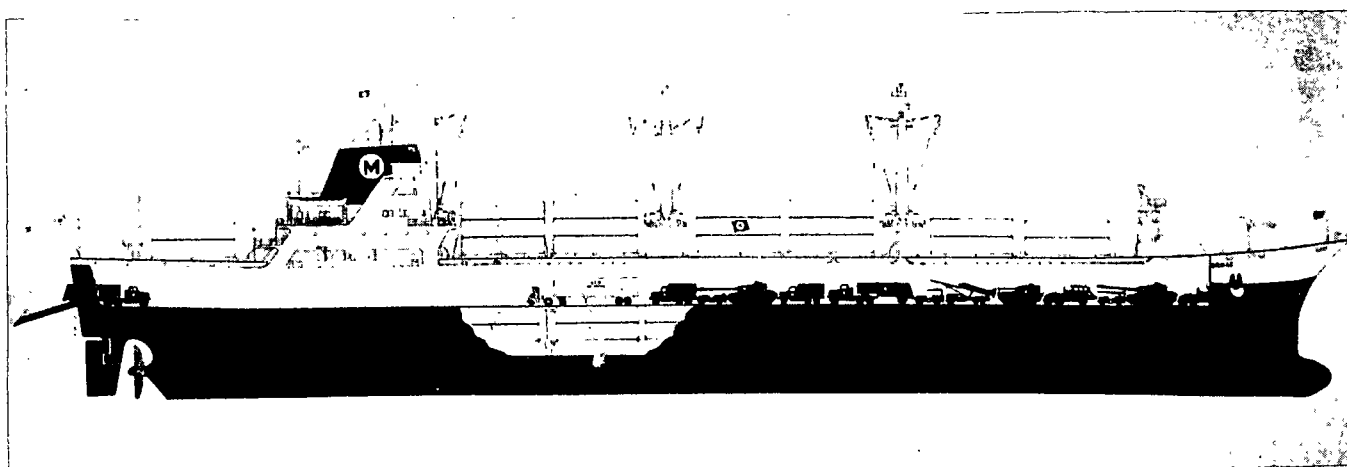


Figure 2-7(1) . Scale drawing of Sea-Bridge class, C5-S-78a.



1

2



3

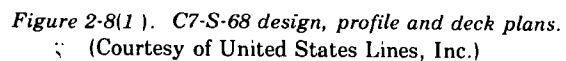
4



g. C6 Vessel. The C6 vessels are all container ships. A few C4's have been converted into C6 container ships.

h. C7 Vessel. The C7-S-68 design within the

C7 type vessel is the largest container ship in existence. It has three deck levels, 10 hatches, and can carry 1,210 containers, including 180 refrigerated (reefer) containers (fig 2-8(1) and (2)).



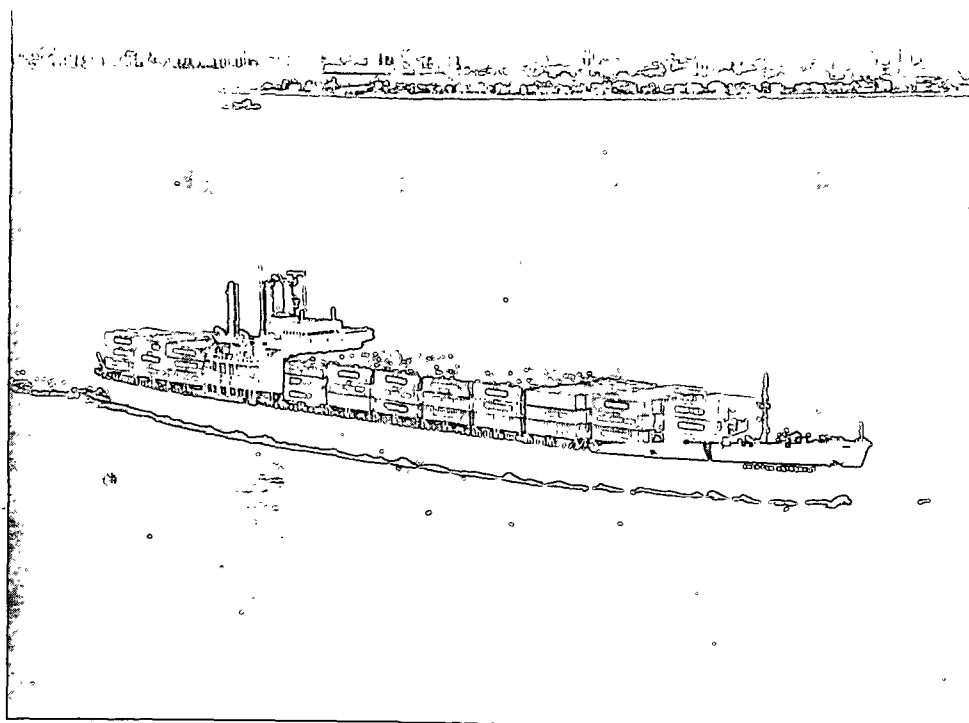


Figure 2-8(2). SS American Astronaut, C7-S-68 design.
(Courtesy of United States Lines, Inc.)

i. *C8 Vessel*. The C8 design, in addition to being the largest cargo vessel afloat, also embodies the newest concept in ocean shipping. These vessels are designed primarily to carry lighters or barges; however, they are also capable of carrying containers, pallets, or any combination, as well as bulk cargo. There are two designs of this type with the same basic concept, the C8-S-81a (LASH) and the C8-S-82a (SEABEE).

(1) *C8-S-81a (LASH)*. The LASH design (fig 2-9) has a 510-ton-capacity gantry crane which lifts the lighters (barges), each having a capacity of 370 long tons, aboard. The LASH vessels also are equipped with a 35-ton-capacity gantry crane so that containers and lighters can be loaded simultaneously. LASH vessels have the capacity to transport 49 lighters and 356 standard 8- by 8- by 20-foot containers.

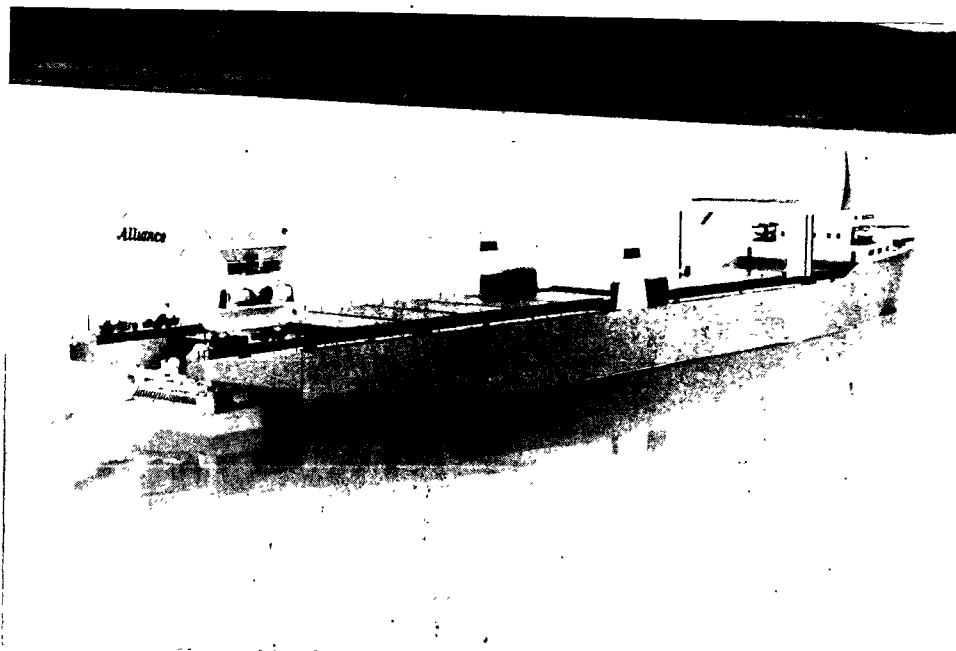


Figure 2-9. C8-S-81a (LASH).
(Courtesy of Alliance Machine Co.)

(2) C8-S-82a (SEABEE). The SEABEE (figs 2-10(1) and (2)), the larger of the two C8 designs, with an overall length of 874 feet, has a 2,000-long ton stern elevator to lift the barges aboard. In loading, the elevator platform is submerged beneath the water where two fully loaded barges can be floated into position on the platform and raised to one of the three deck levels. The average cycle time for simultaneously loading or discharging two barges is 30 to 35 minutes. A built-in system of wheeled hydraulic transporters moves the barges into position for storage. The reverse procedure is used for unloading. The vessel can carry thirty-eight 850-long ton capacity barges as well as a varying number and size of containers as follows:

(a) With all 38 barges on board, a total of three-hundred-eighty 30-foot or five-hundred-thirty-two 20-foot containers can be transported in the barges (ten 30-footers or fourteen 20-footers per barge). In addition, a total of one-hundred-sixty 40-foot containers can be carried on top of the ten barges located on the main (top) deck aft of the ship's superstructure. The restrictive

clearance of the superstructure prevents the transporting of containers on the forward barges if the barges are to be loaded or discharged by the ship's stern elevator.

(b) To increase the ship's container carrying capacity, any number of barges on the main deck can be replaced with container adapters. The replacement ratio is two adapters for each barge. Each adapter (except those beneath the superstructure) will accommodate twenty-four 20-foot or twelve 40-foot containers. The four adapters located under the ship's superstructure are restricted to sixteen 20-foot or eight 40-foot containers due to the overhead clearance restriction.

(c) To achieve maximum container carrying capacity, the two lower decks of the ship can be modified for container adapters. This replacement of barges with adapters (on all three decks gives the ship a maximum capacity of eighteen-hundred 20-foot containers. Loading and discharging of containers not transported in or on the ship's barges must be accomplished by a shoreside or floating crane.

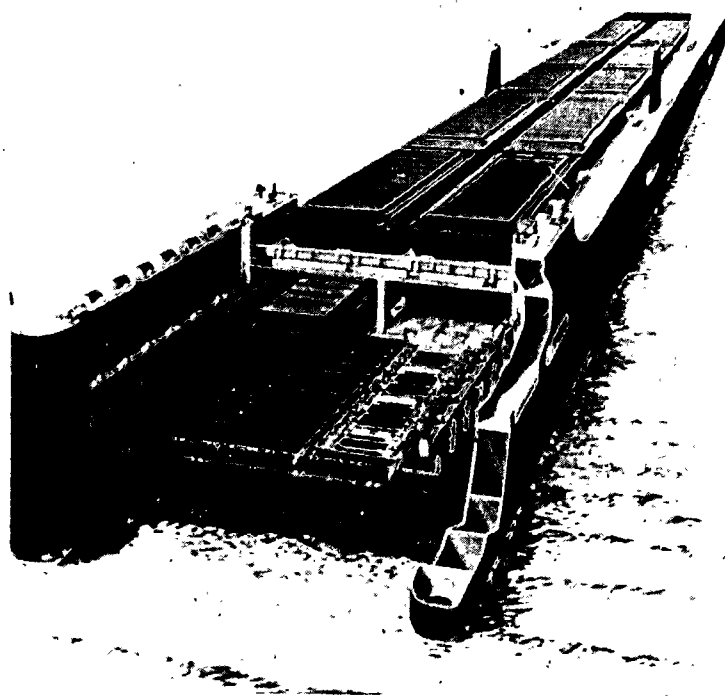


Figure 2-10(1). C8-S-82a (SEABEE), stern view.

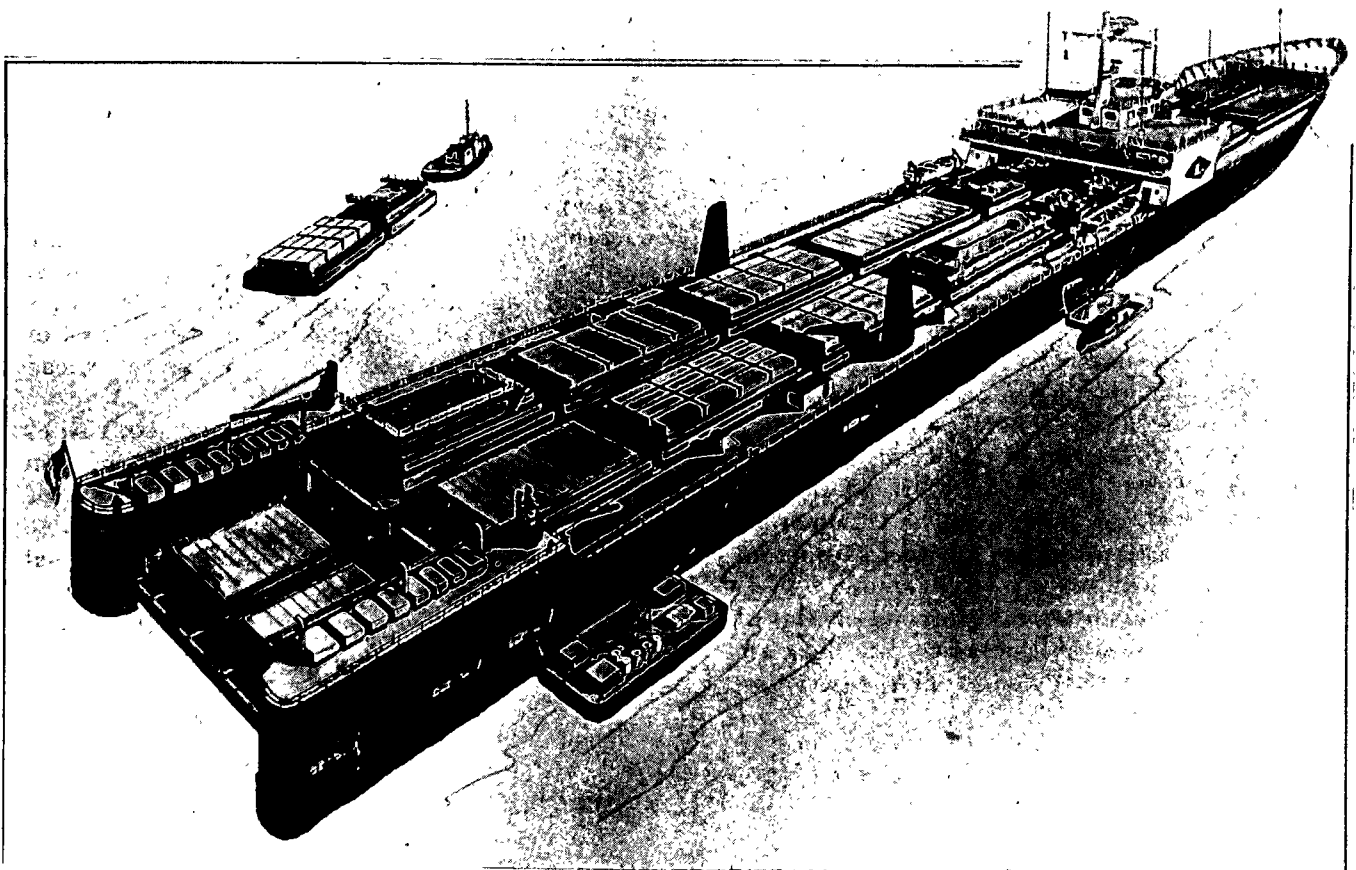


Figure 2-10(2). C8-S-82a (SEABEE), overall view.

j. *Roll-On/Roll-Off (RORO) Vessels.* Ships of this type have been in service for a number of years. No specific C class has been assigned, although some are ex-C4's. The largest and fastest of the RORO vessels, under long term charter to the Military Sealift Command (MSC), is the GTS *Wm. M. Callaghan* (Figs 2-11(1) and

(2)). It has side access and stern ramps for roll-on/roll-off operations, six hatches featuring two heavy lift booms which can operate in tandem (240-ton capacity), and conventional cargo handling gear of 15-ton capacity. The smaller USNS *Comet* is another type of roll-on/roll-off vessel (fig 2-12).

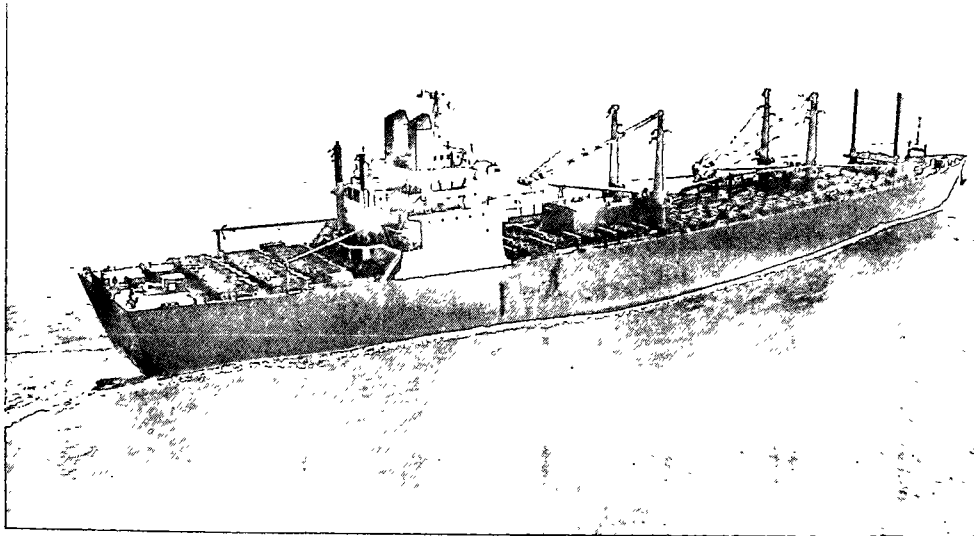
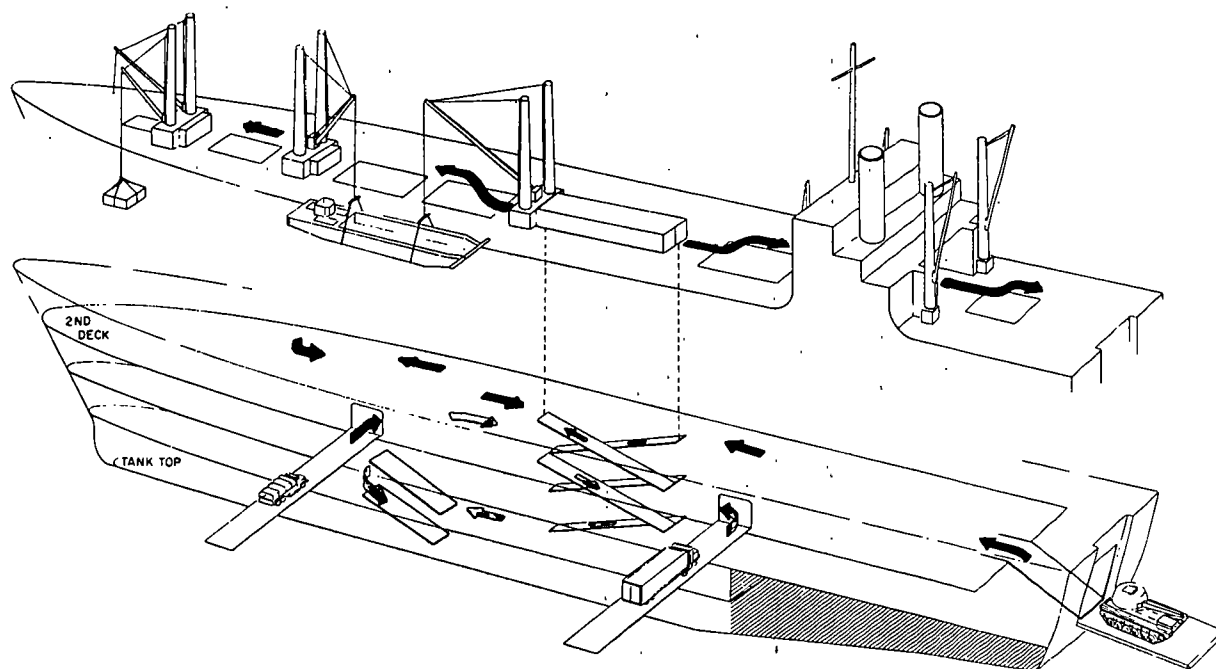
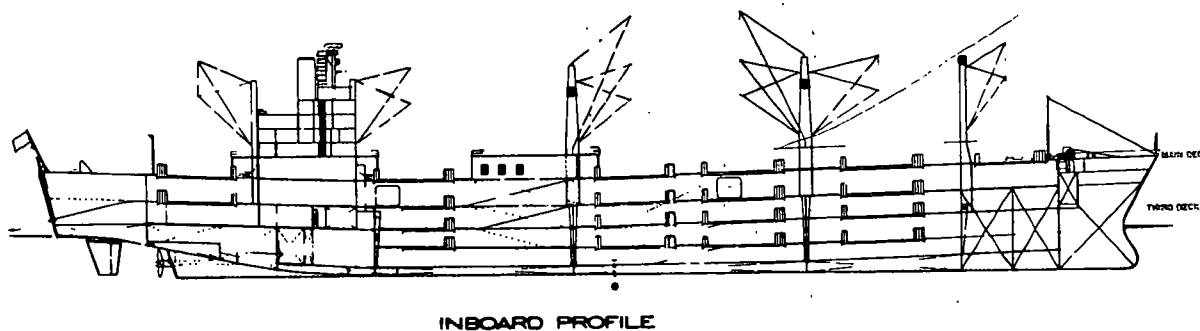
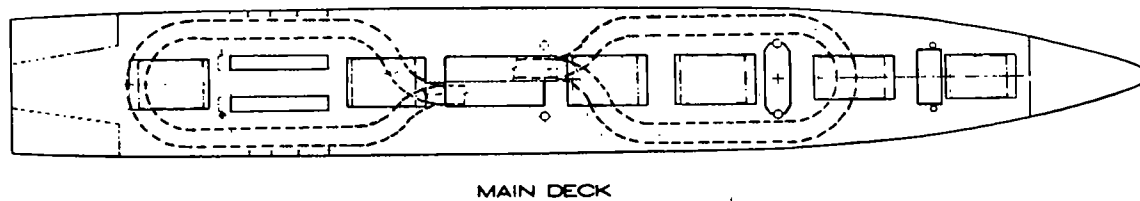
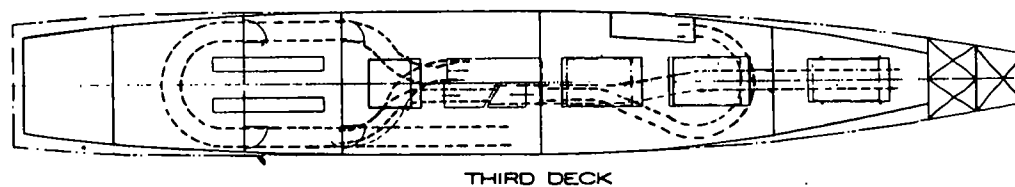


Figure 2-11(1). GTS *Wm. M. Callaghan*, roll-on/roll-off vessel.



CARGO TRAFFIC PATTERN



PROFILE AND DECK PLANS

Figure 2-11(2). GTS Wm. M. Callaghan, profile and deck plans.

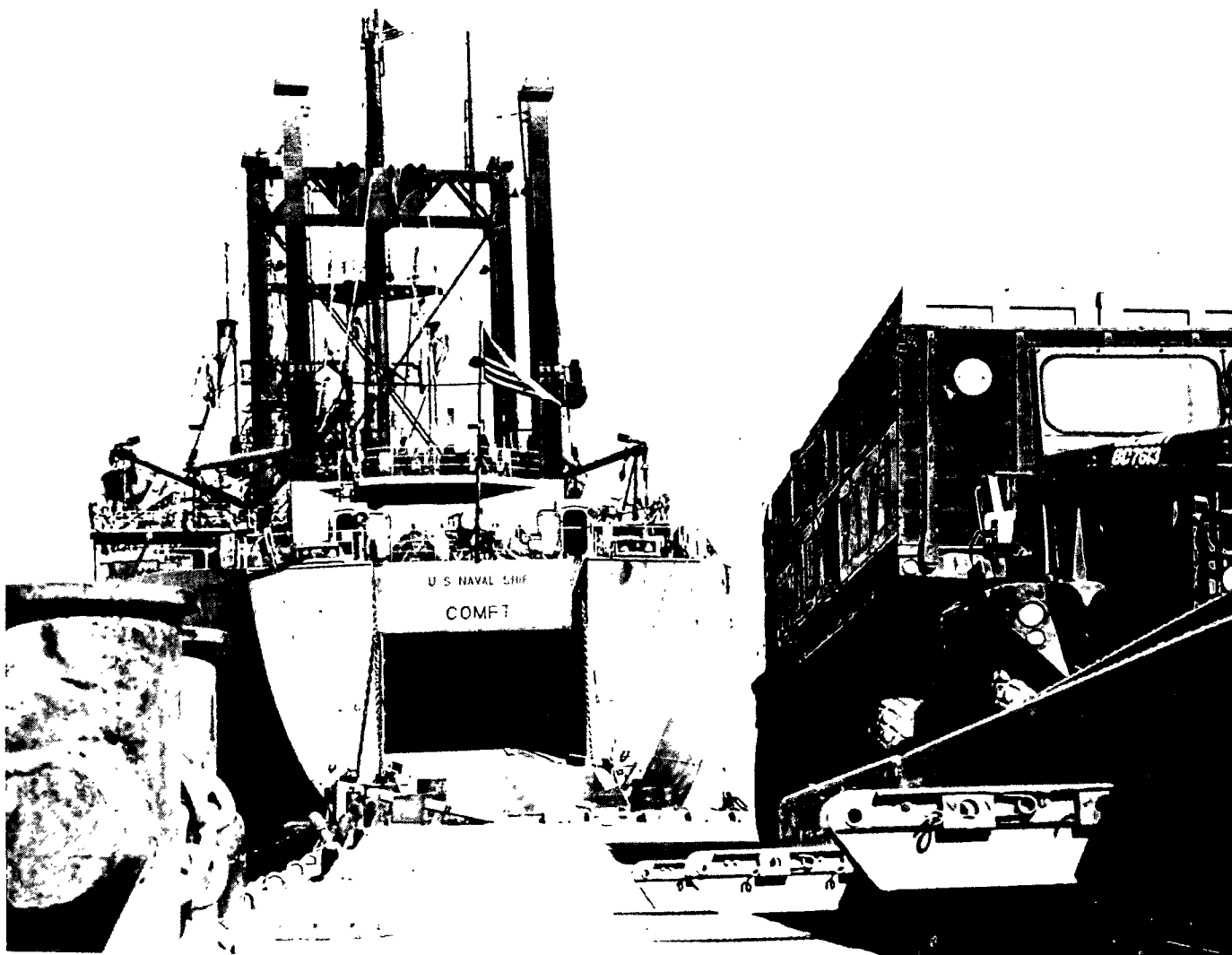


Figure 2-12. USNS Comet, roll-on/roll-off vessel.

k. *Seatrains and Heavy Lift Ships.* Converted T2 tankers have been chartered by MSC to move vehicles, containers, aircraft, and other odd and outside cargo items. These ships feature a single hatch opening, 56 by 37 feet, served by two 50-ton rotating gantry cranes; decks unencumbered by stanchions and bulkheads with heights of at least 14 feet; recessed rail tracks and tiedown fittings; and a flat spar deck above the upper deck suitable for helicopter landing and takeoff (fig 2-

13). A useful heavy lift ship, chartered by MSC, is the SS *Transcolorado* (fig 2-14) which, along with the SS *Transcolombia*, is a converted C4 troop transport ship with five hatches. The two largest hatches, numbers 3 and 4, are 75 by 35 feet, and each is served by two 15-ton booms, plus one of 120-ton capacity. The two 120-ton Stuelcken booms can be married to give either hatch a 240-ton capacity.

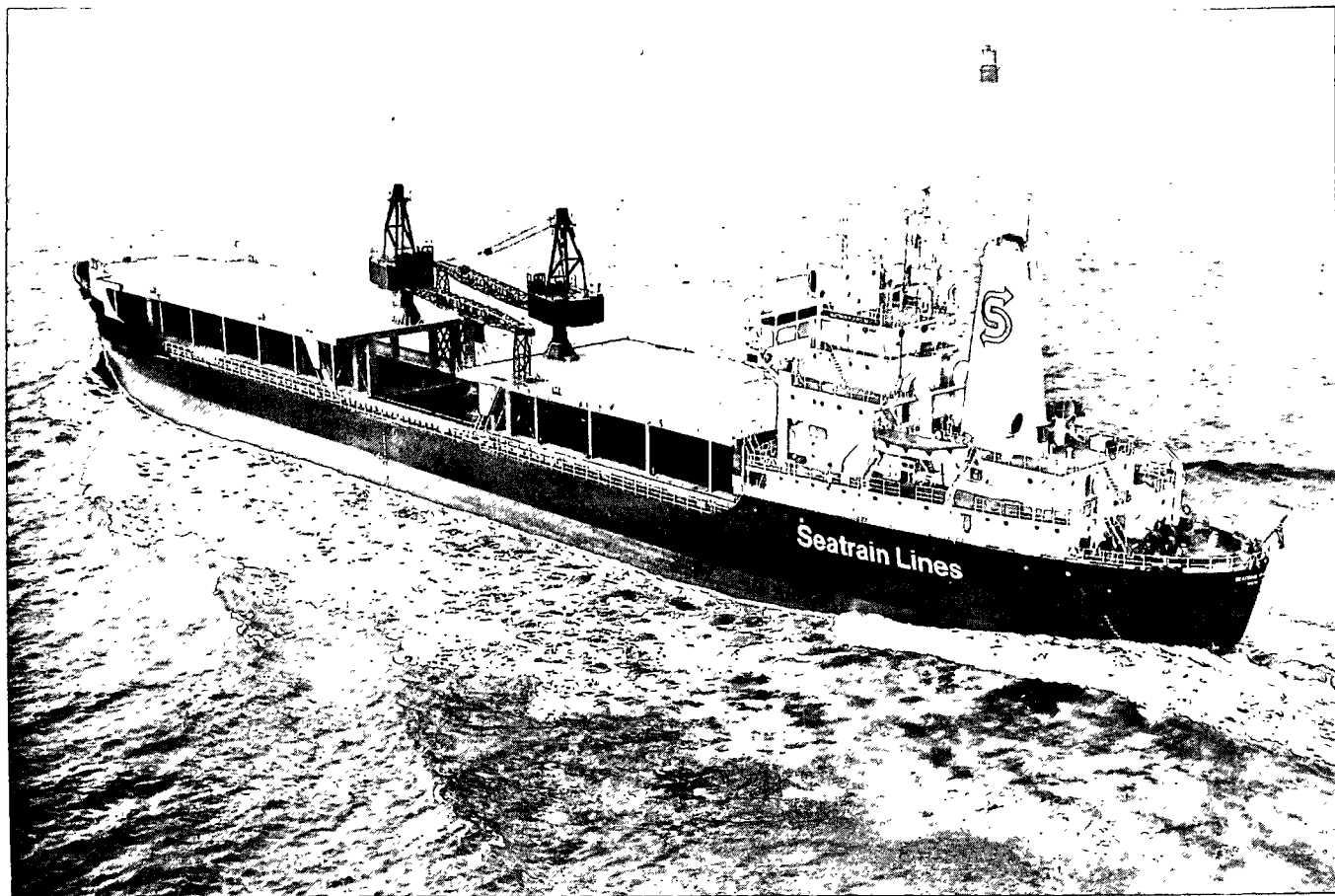


Figure 2-13. Seatrain Puerto Rico.

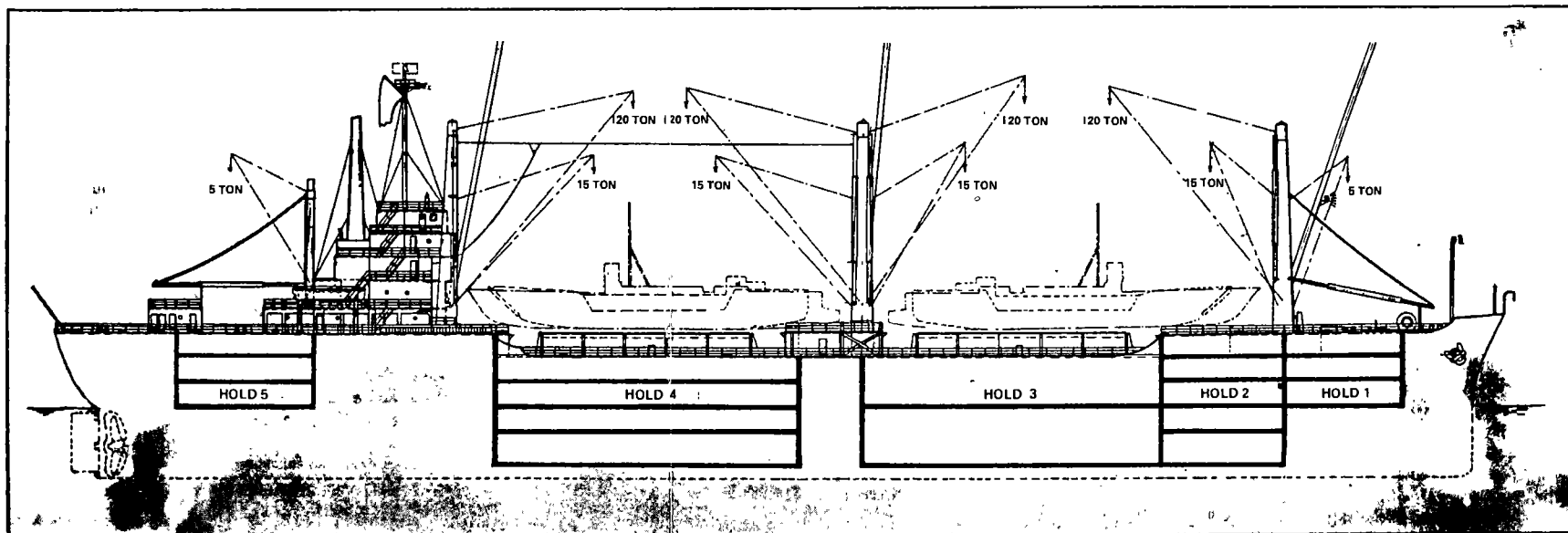


Figure 2-14. Profile of heavy lift vessel SS Transcolorado.

1. Multipurpose Dry Cargo Ships. The Department of Defense (DOD) is attempting to develop a fleet of these ships to replace the Victory and C2 ships. These ships, with container, break-bulk, heavy lift, and roll-on/roll-off capabilities, will be approximately 650 feet in length and have a total displacement of 29,958

tons. Each vessel will have one 210-ton boom, eight 26-ton booms, and six 42-ton booms. Each vessel will also have 2 million cubic feet of dry cargo capacity, 149,000 square feet of roll-on/roll-off deck area, and be able to carry 1,044 standard 20-foot containers (fig 2-15).

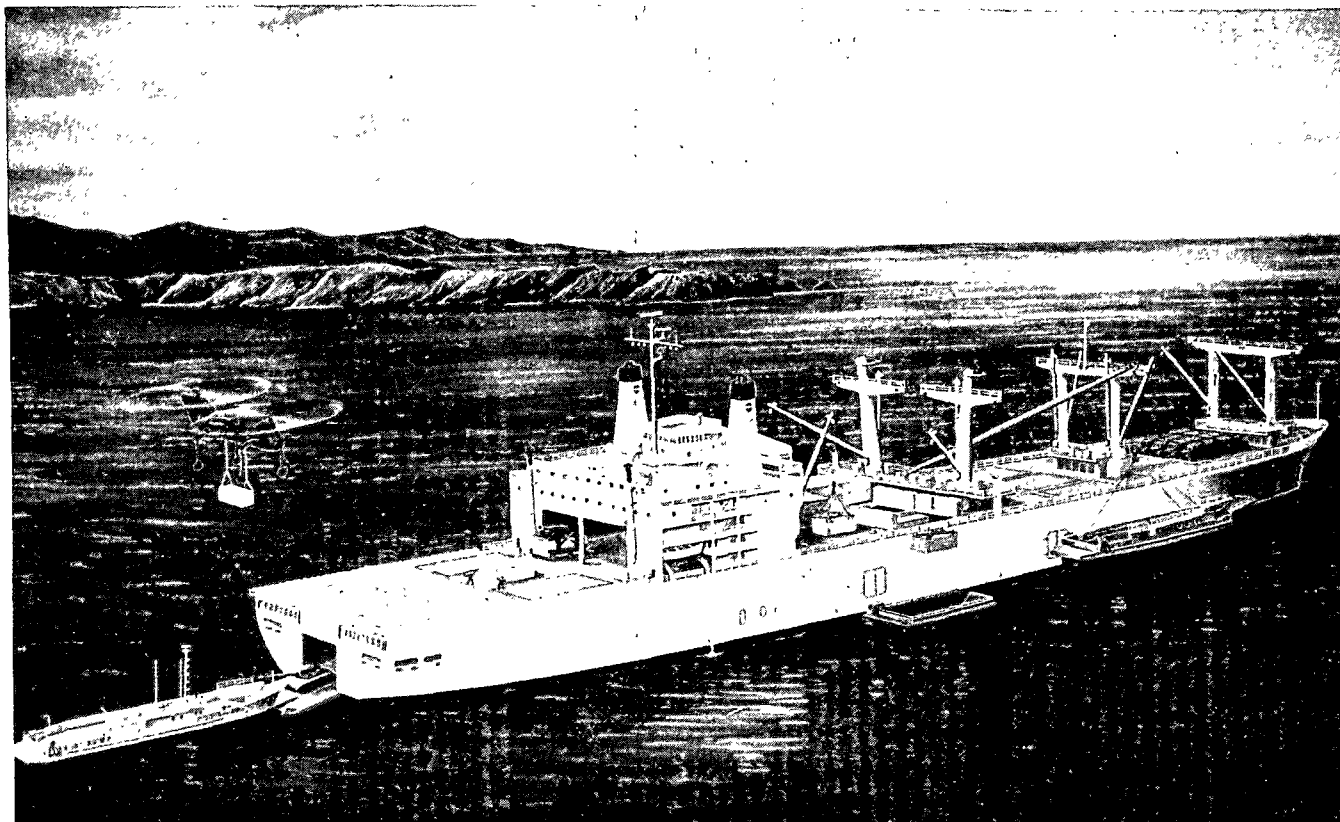


Figure 2-15. Multipurpose dry cargo vessel.

Section II. PLANNING FACTORS

2-5. Vessel Tonnage Terms

In planning cargo loading, every cargo vessel has two inherent physical limitations: the volume and the weight of cargo it can carry. The cargo planner, therefore, must understand volume and weight terms related to the vessel and its cargo. Practical application of these terms is shown in section III.

a. Volume or Space Tons. Volume or space tons expressing measurement of volume used in ocean shipping are—

(1) *Measurement ton.* A measurement of the space occupied by cargo, expressed in units of 40 cubic feet. To determine the number of measurement tons of cargo, multiply height by length by width and divide the results by 40.

(2) *Displacement ton.* A unit of measure approximately equal to the volume of a long ton of sea water (35 cubic feet). It is used in determining the displacement of vessels.

b. Weight Tons. Weight tons expressing measurements of weight are—

- (1) Long ton—2,240 pounds.
- (2) Short ton—2,000 pounds.
- (3) Metric ton—2,204.6 pounds.

c. *Tonnages.* Weight and volume tons when applied to vessels are expressed as—

(1) Volume or space tonnage consisting of gross and net tonnage.

(a) Gross tonnage is the internal cubic capacity of the vessel expressed in gross tons. It is also called gross registered tonnage. One hundred cubic feet is equivalent to one gross ton.

(b) Net tonnage is the tonnage remaining after deducting from the gross tonnage all nonrevenue-producing space taken by the boilers, engines, shaft alleys, steering apparatus, chain lockers, charthouse, crew quarters, and other space not available for carrying cargo or passengers.

(2) Weight or displacement tonnage measured in two ways.

(a) Displacement loaded is the weight in long tons of the entire ship—the vessel itself, fuel, water, stores, dunnage, crew, and cargo.

(b) Displacement light is the weight in long tons of the vessel less cargo, passengers, fuel, water, stores, dunnage, ballast (fixed and temporary), crew, and cargo.

(3) Deadweight tonnage, the total carrying capacity of a vessel, or the difference between displacement light and displacement loaded, expressed long tons. It includes the weight of fuel, water, stores, dunnage, ballast, crew, and cargo.

(4) Cargo deadweight tonnage, the actual payload of the vessel. It is obtained by deducting the weight of fuel, water, stores, subsistence, dunnage, ballast, and crew from the deadweight tonnage.

d. *Bale Cubic Capacity.* Bale cubic capacity is the volume of space available for loading cargo which is measured in cubic feet. It extends from the inside of the cargo battens, which are mounted on the frames, to the underside of the deck beams. This measurement is used to compute the space available for general cargo.

e. *Grain Cubic Capacity.* Grain cubic capacity is the maximum space available for cargo. It is measured in cubic feet from the inside of the shell plating to the underside of the deck plating. This measurement is used for computing cubic space available for loading bulk commodities.

2-6. Factors Used in Stowage Planning

The amount of cargo that can be placed in a vessel will vary in accordance with the skill and com-

pactness with which it is stowed. The factors used in determining the space available in the vessel for cargo, the amount of cargo that can be stowed, and the most economical use of the space are—

a. *Broken Stowage.* Broken stowage is cargo space which is lost in the holds of a vessel because of the contour of the hull and/or the shape of the cargo. Dunnage, ladders, and stanchions are included in broken stowage. It is expressed as a percentage figure that is an estimation of the space that will be lost. The percentage factor may be applied to the cargo or the ship's space.

b. *Stowage Factors.* A stowage factor is the relation of cube (cargo or space) to weight (cargo). Three stowage factors used in vessel cargo planning are—

(1) The cargo stowage factor, a number that denotes the cubic feet of space required to stow 1 long ton of a specific commodity. For lots of 1 long ton or more, this factor is obtained by dividing the cubic measurement in feet by the weight in long tons. For example, given 40,961 cubic feet of C rations weighing 666 long tons, by dividing 40,961 by 666, a stowage factor of 61.5 or 62 is obtained. For lots weighing less than 1 long ton, the cubic measurement in feet is divided by the weight of the cargo in pounds and multiplied by 2,240. Thus, if 1,120 pounds of C rations occupies 31 cubic feet, the stowage factor is 62. For example:

$$\frac{31}{1,120 \times 2,240} = 61.8 \text{ or } 62 \text{ (cargo stowage factor)}$$

(2) The vessel stowage factor (VSF), a number that represents the relationship between the cargo deadweight tonnage and the space available for stowing cargo below deck. The vessel stowage factor is determined by dividing the space (expressed in cubic feet) available below deck for loading cargo by the weight (expressed in long tons) of the cargo to be loaded below deck. The VSF is used to allocate tonnage to be loaded in each compartment (para 2-14).

(3) The compartment stowage factor, a number that expresses the relationship between the long tons of cargo allocated to a compartment and the cubic space within that compartment, less an allowance for broken stowage. The compartment stowage factor is obtained by subtracting an allowance for broken stowage from the cubic capacity of the compartment and dividing the difference by the long tons allocated to the compartment. Whereas the vessel stowage factor is used to determine basic tonnages going to each compartment, the compartment stowage

factor helps determine the commodities used to fill those tonnage allocations. For example, compartments with low compartment stowage factors (high broken stowage) will tend to be filled with high density items and vice versa (para 2-17b(2)).

c. *Free Space.* This is space in the hold that is available for additional cargo after loading has been completed. It is frequently necessary to determine free space in order to know how much cargo can be loaded at other ports of call.

d. *Full and Down.* A vessel is said to be full and down when all the available cubic capacity has been used (full) and sufficient weight is aboard to submerge the vessel to its legal loadline (down). All the weight-lifting and cubic capacities of the vessel have then been used.

e. *Draft.* Draft is the vertical distance

measured from the lowest part of the hull to the waterline.

f. *Draft Marks (fig 2-16).* Draft marks are numerals located on each side at the bow and stern to indicate the draft; i.e., the distance from the keel to the waterline. The numbers are 6 inches high and are spaced 12 inches apart, vertically, from the bottom of one mark to the bottom of the next mark. They are as close to the bow and stern as possible. The bottom of the number indicates the foot mark: inches must be estimated by the distance of the waterline above the top or below the bottom of the figure. Thus, if the waterline is at the middle of the 3 rather than at the bottom, the draft is approximately 3 feet 3 inches rather than 3 feet exactly. Draft marks can be used to indicate the effect on a ship's trim caused by cargo or fuel being loaded on it.

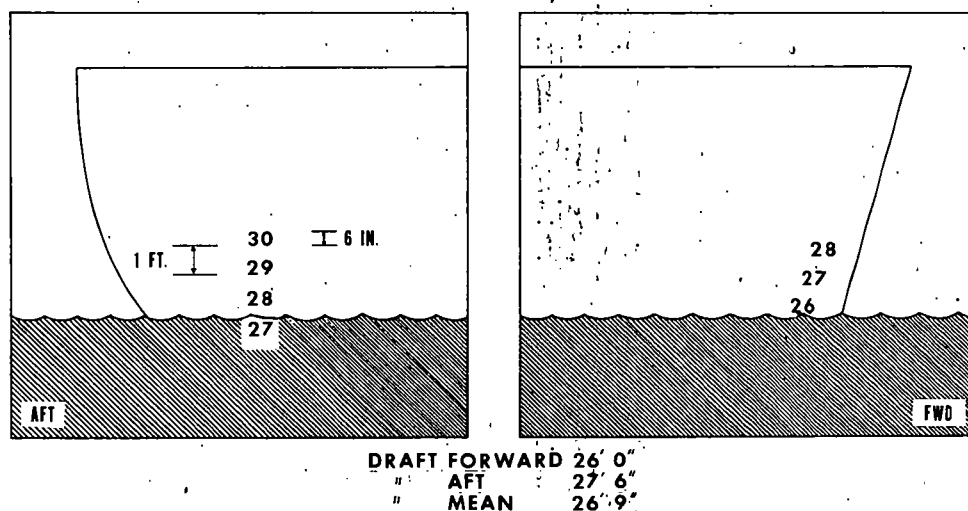


Figure 2-16. Draft marks.

g. *Mean Draft.* The mean draft is the average of the drafts measured at bow and stern. For example, if the draft forward is 26 feet and the draft aft is 27 feet 6 inches, the sum of the two readings is 53 feet 6 inches. Dividing the sum by 2 gives the mean draft: 26 feet 9 inches.

h. *Freeboard.* Freeboard is the distance from the upper edge of the main deck line measured amidships to the water.

i. *Trim.* Trim is the difference between the drafts at bow and stern; i.e., forward and aft. It shows the longitudinal position of the ship in relation to the stillwater level when viewed from broadside.

j. *Down by the Head.* A situation in which a vessel's draft forward is deeper than her draft aft.

k. *Down by the Stern.* A situation in which a vessel's draft aft is deeper than her draft forward.

l. *Sagging.* A ship that is loaded heavier amidships than it is forward and aft will have a tendency to sag, especially when its bow and stern are supported by seas while its amidships is in a trough. The tendency of the vessel to arch down or sag results in a bending movement which stresses the top members of the vessel in compression and the bottom members in tension.

m. *Hogging.* The reverse of sagging, hogging is the tendency of a ship to arch up amidships as the result of too much weight at the ends and not enough amidships.

n. *List.* List is the inclination or leaning of a vessel caused by an unequal lateral distribution of weight in the ship. This condition can be avoided by loading equal amounts of cargo (weight) in the wings and stowing heavy lifts as near to the centerline as possible.

o. Stability. Stability is the tendency of a ship to return to its original position after it has been displaced. A ship has both longitudinal and transverse stability. Longitudinal stability is achieved through the even distribution of weight through the length of the ship. Fairly good transverse stability may be obtained on some types of ships through the application of the rule of thumb "two-thirds of the cargo by weight in the lower holds and one-third in the 'tween decks." But the planner who understands the fundamental principles of stability can load a ship with as nearly perfect stability as it is possible to obtain.

(1) *Longitudinal stability.* Longitudinal stability confines pitching, which is the vertical rise and fall of a ship's bow and stern caused by a head sea or following sea. To obtain the desired degree of longitudinal stability, the combined weight of the ship, stores, fuel, and cargo must be evenly distributed.

(2) *Transverse stability.* Transverse stability reduces the danger of extreme rolling or capsizing. Care must be taken not to put too much weight in the upper decks, as this makes a tender ship; too much weight in the lower holds makes a stiff ship. A ship that is excessively stiff will roll violently and can be damaged by heavy stresses on the hull and superstructure. Cargo in the upper 'tween decks will have a tendency to

shift athwartship in a stiff ship. The ability of a ship to right itself when rolled to one side depends upon the relation of the center of gravity of the vessel to its center of buoyancy. The forces involved are described below.

(a) *Center of gravity (G).* The center of gravity is the center of the mass of the ship's total weight and the height of the center of gravity; therefore, the range of a ship's stability is influenced by the manner in which it is loaded. As weight is added to the lower part of the ship, the center of gravity is lowered, and therefore, the stronger the righting effect. If the center of gravity is too low, however, the ship becomes stiff. As weight is added to the upper part of the ship, the center of gravity is raised, thereby creating a tender ship.

(b) *Center of buoyancy (B).* The center of buoyancy is the geometric center of the underwater body of the ship, or the center of all the upward forces keeping it afloat. When the ship is on an even keel the center of buoyancy (B) like the center of gravity (G) is located on the ship's centerline (fig 2-17). Unlike the center of gravity, however, the center of buoyancy changes its location in relationship to the centerline. Figure 2-18 illustrates how the center of buoyancy has moved from position B to position B' during a roll of the ship.

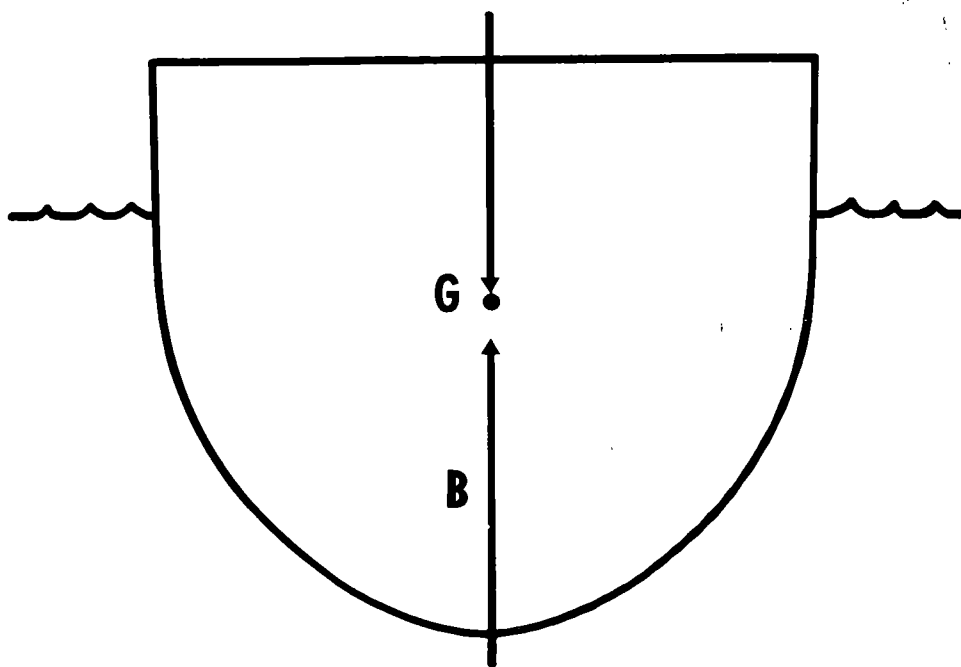


Figure 2-17. Center of gravity and center of buoyancy (ship on even keel).

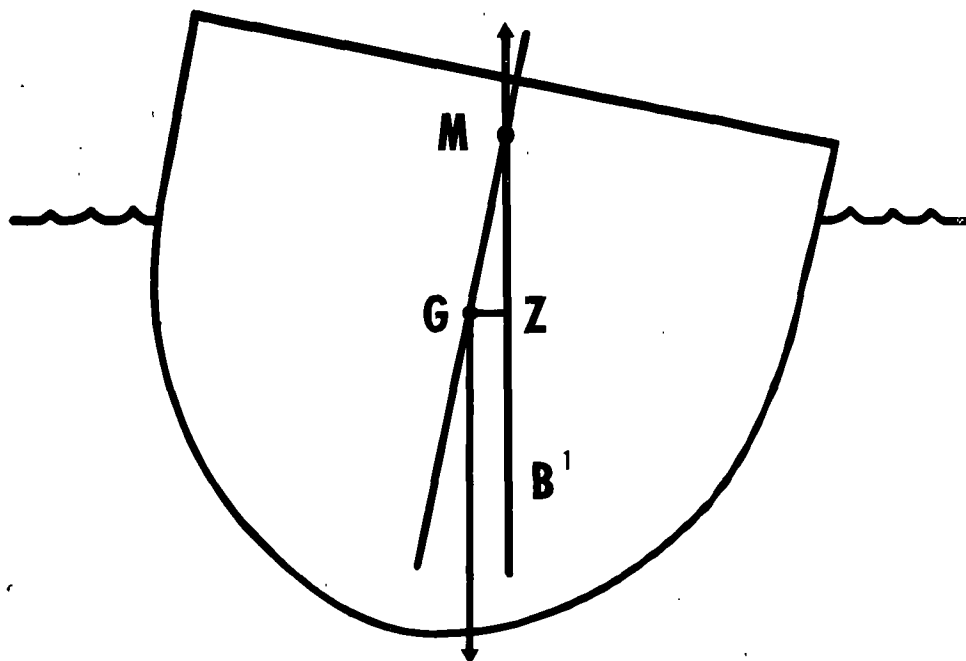


Figure 2-18. Forces involved in transverse stability during ship's roll.

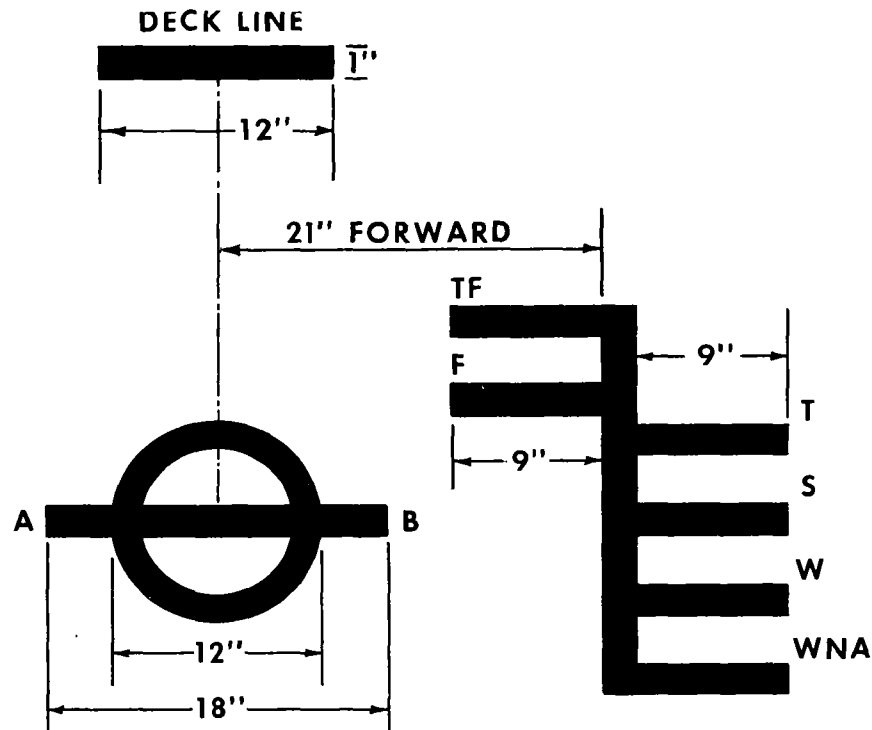
(c) *Metacenter (M)*. The metacenter is the point at which the center of the buoyant forces (B) intersects the ship's centerline during a roll or heeling of the ship. The situation shown in figure 2-18, with M above G, is the usual one on a stable ship. If G was above M, the ship would be in a very unstable condition.

(d) *Metacentric height (GM)*. The metacentric height is the height of the metacenter (M), above the center of gravity (G); it is a measure of the initial stability of a vessel. This is expressed as a negative distance when G is above M and, as mentioned above, indicates the vessel is in a very unstable condition, subject to capsizing.

(e) *Righting arm (GZ)*. The horizontal line between the center of gravity (G) and the line of buoyancy (B) is referred to as the righting arm (GZ). The length of GZ, or the distance between

the parallel lines of the upward (B) and downward (G) forces designate the extent of the righting arm, which tends to return the ship to an even keel. If weight were added to the lower part of the ship, the center of gravity (G) would be lowered. As G is lowered, the righting lever GZ becomes longer, and the ability of the ship to return to an upright position is increased.

p. *Loadline*. As provided in the Loadline Act of 1929, the American Bureau of Shipping assigns loadlines and issues loadline certificates to American ships. The loadline or Plimsoll mark is placed amidships on both sides of the hull of a vessel to denote the maximum mean draft to which a vessel may be lawfully submerged for a particular voyage, depending upon the area to be traveled and the season of the year. Figure 2-19 illustrates the loadlines found on American oceangoing cargo vessels.



EXPLANATION OF SYMBOLS

TF TROPICAL FRESH-WATER LOADLINE
 F FRESH-WATER LOADLINE
 T TROPICAL LOADLINE
 S SUMMER LOADLINE
 W WINTER LOADLINE
 WNA WINTER NORTH-ATLANTIC LOADLINE
 AB AMERICAN BUREAU OF SHIPS

Figure 2-19. Loadline.

(1) The deckline mark is a line 12 inches long and 1 inch wide located on each side of the hull amidships directly opposite the main deck plating and directly over the loadline.

(2) A loadline disk is 12 inches in diameter with a centerline 18 inches long and 1 inch wide running through it horizontally. It is located amidships directly below the deckline. The top of the centerline denotes the maximum draft at which the vessel may be immersed in saltwater during the summer months. The initials of the authority which assigned the loadline are indicated by letters AB alongside the disk above the centerline.

(3) Additional markings denote the draft to which the vessel may be loaded at different seasons of the year and in various types of water. These markings consist of a vertical line 21 inches

forward of the center of the disk, with horizontal lines 9 inches long extending to the right and left of the vertical line to denote the various drafts. The upper edge of the summer saltwater loadline is located at the same height as the centerline on the disk.

2-7. Physical Characteristics of Vessel

a. The structural characteristics of a vessel may present limiting factors that should be considered before loading. The stowage and capacity booklets published by the US Maritime Administration for various vessel designs are very useful to the cargo planner for determining these limiting factors. The stowage and capacity booklet contains such information as—

- (1) Size of hatches.
- (2) Headroom under deck.

- (3) Weight limitations per square foot.
- (4) Capacity of cargo booms.
- (5) Obstructions (e.g., ladders, escape hatches, bulkheads, and overhead beams).
- (6) Vessel capacities (e.g., bale cubic, grain cubic, fuel, water, and stores).
- (7) Vessel deadweight scale.
- (8) Trim table.
- (9) Loadlines.
- (10) Deck plans.

b. If a stowage and capacity booklet is not available for the ship being loaded, the information listed in *a* above may be obtained from the local representative of the Military Sealift Command or by radio from the vessel itself if the situation warrants.

c. It should be noted that one structural feature—containerization capability—vastly affects all of the loading factors discussed in the following paragraphs. Hence, Part Two of this manual will be devoted to containerization, while noncontainerized loading will be covered here.

2-8. Vessel Deadweight Scale

a. The planner should know the deadweight tonnage of the vessel prior to planning the loading. This is determined by using the vessel deadweight scale. A particular vessel's deadweight scale gives the deadweight and displacement tonnages and the effects these tonnages have on the mean draft. The deadweight scale is made up of four columns (fig 2-20).

DEADWEIGHT SCALE			
DEADWGT-TONS-SW	DRAFT-FT TO BOT OF KEEL	DISPL - TONS-SW	TONS/IN
11,000	29		
10,805	28 1/4	15,200	
	28	15,000	51.0
10,000	27		
	26	14,000	
9,000	25	13,000	50.0
	24		
8,000	23	12,000	49.0
	22		
7,000	21	11,000	48.0
	20	10,000	
6,000	19		
	18	9,000	47.0
5,000	17		
	16	8,000	
4,000	15	7,000	46.0
	14		
3,000	13	6,000	45.0
	12		
2,000	11	5,000	44.0
	10		
1,000	9	4,395	
0	8	4,000	

TOP OF MAIN DECK AT SIDE

KEEL DRAFT 28'-6 3/4"
DISPLACEMENT 15,200 T (SW)

LIGHT SHIP

Figure 2-20. Vessel deadweight scale.

(1) The left column headed "Deadwgt Tons-SW" (deadweight tons-saltwater) is the lift capacity of the vessel. It shows the number of tons that may be carried in the vessel, including fuel, stores, ballast, water, dunnage, and cargo, or anything that may be placed in the vessel, excluding machinery or equipment necessary for the operation of the vessel.

(2) The second column from the left, headed "Draft-ft to Bot of Keel" (draft-foot to bottom of keel), shows the mean draft in feet and inches. This scale is graduated from the minimum draft of 8 feet to a maximum of 29 feet. The maximum legal draft to which this particular vessel may be loaded is 28 feet 6-3/4 inches. This is based on the legal loadline in summer saltwater.

(3) The third column from the left, headed "Displ Tons-SW" (displacement tons-saltwater), gives the displacement tonnage of the ship plus any material placed in the vessel.

(4) The column on the right, headed "Tons/In." (tons per inch), denotes the number of long tons required to change the mean draft of the vessel 1 inch at various drafts.

b. The deadweight scale is used by the cargo planner to determine what the draft of the vessel will be after a given number of tons have been loaded. Using the deadweight scale shown in figure 2-20, it can be determined that a Victory vessel loaded with 9,000 long tons, including fuel, water, stores, cargo, etc., has a mean draft of 25 feet 4 1/2 inches at the beginning of the voyage. Using 50 long tons of fuel, water, and stores per day of sea travel, it uses 500 tons in a period of 10 days, thus reducing the mean draft to 24 feet 6 inches. From the deadweight scale, the cargo planner can determine the draft of the vessel at the completion of the trip, and he will know whether the draft is correct for the harbor in which the vessel will be discharged.

c. To determine the cargo deadweight tonnage of a vessel, the deadweight tonnage must be known. This is given in the deadweight scale (fig 2-20) as 10,805 long tons, the total lift capacity of the Victory vessel. In the deadweight column, the number 0 is listed directly opposite the displacement tonnage for the light ship. Cargo deadweight tonnage is determined by deducting the weight of operating supplies, i.e., fuel, water, stores, subsistence, dunnage, ballast, and the crew, from the deadweight tonnage. The numbers above 0 indicate tonnages added to the vessel in the form of operating supplies and cargo. Additional weight increases the ship's mean draft. If 10,805 long tons are added to the light ship, the

vessel will be forced down in the water to a mean draft of 28 feet 6 3/4 inches. When the vessel has a mean draft of 28 feet 6 3/4 inches, it has reached displacement loaded. More than 10,805 long tons would bring the mean draft above the legal loadline, and it could not legally sail. For example, assume that the vessel to be loaded will have on board—

	Long tons
Stores	340
Fuel oil	1,700
Fresh water	240
Dunnage	100
Total Operating Supplies	2,380

The maximum deadweight tonnage (10,805 long tons) minus operating supplies (2,380) equals 8,425 cargo deadweight tons (CDWT), the long tons that may be loaded aboard the Victory vessel.

2-9. Weight Distribution

The weight of the cargo to be loaded should be prorated throughout the cargo compartments. Tonnage must be distributed so that no undue strain is placed on any one part of the vessel. An efficient method used to determine distribution is the application of the vessel stowage factor (VSF).

a. To determine the VSF, the planner must first determine the cubic feet of space available for stowing cargo in the vessel. Bale cubic capacity is used for general cargo; grain cubic capacity is used for bulk cargo. Then he must take the following steps:

(1) Deduct the weight of on-deck cargo from the cargo deadweight tonnage to determine the long tons that will be stowed below the weather deck.

(2) Divide the bale cubic space available for loading cargo by the long tons to be loaded below deck; the result of this computation is the vessel's stowage factor.

(3) Then divide the cubic capacity of each cargo compartment (found in the vessel stowage and capacity booklet) by the vessel stowage factor to determine the long tons to be allocated to each compartment.

b. To illustrate this weight distribution method, assume that all cargo will be stowed below deck in a vessel having a bale cubic capacity of 456,525 cubic feet and a cargo carrying capacity of 8,425 long tons. This gives a vessel stowage factor of 54.2. If only 7,430 long tons are allocated, the bale cubic capacity of the vessel (456,525 cubic feet) divided by the weight of the cargo available for loading (7,430 long tons) results in a VSF of 61.4. The cubic capacity of

each cargo compartment is then divided by the VSF to determine the number of tons to be planned for each compartment.

2-10. Trim Table

a. The trim of a vessel is the difference of the drafts, forward and aft. Trim is largely dependent upon the stowage of cargo. Most masters prefer the stern to be from 2 to 6 feet deeper in the water than the bow. The term drag is used to describe this condition.

b. If a drag or a trim other than that obtained by using the VSF is desired, the ship's trim table should be used. Figure 2-21 shows the profile of a Victory ship, and directly below the profile is the ship's trim table. The purpose of this monograph type diagram is to give an approximate indication of the plus or minus changes in draft (in inches) that will occur as the result of adding a 100-ton load at any selected location on the ship.

c. The trim table shows two scales—the upper one marked “28-foot draft” and the lower one marked “20-foot draft.” The 20-foot scale is used for mean drafts up to 24 feet; the 28-foot scale is used for drafts over 24 feet. The scale closest to the vessel's mean draft should be used. For example:

(1) Assume that 200 long tons are to be loaded in hold No. 2 and that the weight will be distributed evenly throughout the hold. The draft before loading is 18 feet 6 inches forward and 23 feet 4 inches aft. Since the mean draft is less than 24 feet, the correction figure directly under the center of the hold on the 20-foot scale is used. The forward draft will increase 7.2 inches, and the aft draft will decrease 3.2 inches for each 100 tons

loaded in this location. When the corrections are multiplied by 2 (200 tons to be loaded), it indicates that the bow will sink 14.4 inches and the stern will rise 6.4 inches causing the draft to change to 19 feet 8.4 inches forward and 22 feet 9.6 inches aft.

(2) If the 200 tons were placed in the forward end of the hold, the correction figures directly under that location should be used. The change in draft can be determined in the same manner as in (1) above.

d. To maintain the proper trim during loading, it is necessary to check the forward and aft drafts periodically and correct the distribution of weight before the ship gets completely out of trim.

Section III. CARGO PLANNING

2-11. Overall Cargo Load Planning

Upon notification that a vessel is to be loaded, the cargo planner should begin to formulate a plan for loading the vessel. A prestowage plan is seldom firm, and it is frequently necessary to change the plan. However, having a prestowage plan helps expedite cargo loading and helps insure that maximum use is made of the vessel's deadweight carrying capacity.

2-12. Overall Cargo Load Planning

a. Planning for the vessel loading should include the following basic steps:

(1) *Obtaining vessel characteristics.*

(a) The first step the cargo planner takes when preparing the cargo loading plan is to secure the following information pertinent to the particular cargo vessel to be loaded:

1. Vessel descriptions.

(a) Type of vessel—Victory Ship, design VC2-S-AP2.

(b) Number of hatches—five.

(c) Capacity and location of cargo booms:

5-ton—all hatches

30-ton—No. 4 hatch

50-ton—No. 3 hatch

(d) Whether discharge at destination must be accomplished by ship's gear is not applicable to this problem. However, all cargo

planners must be familiar with the discharge capabilities of all the ports of discharge for which cargo must be loaded.

2. Vessel capacities.

(a) Bale cubic capacity—456,525 cubic feet.

(b) Deadweight tonnage—10,805 long tons.

(c) Weight of fuel, water, stores, etc.—2,380 long tons.

(d) Cargo deadweight tonnage (vessel deadweight less fuel, stores, etc.)—8,425 long tons (see para 2-7 and 2-8 for detailed computation).

(e) Estimated deck cargo space—8,000 square feet (approximate).

(f) Seasonal load draft—summer saltwater—28 feet 6 ¾ inches.

(b) The foregoing information can be obtained from three sources:

1. Stowage and Capacity Booklets published by the US Maritime Commission for the particular designs involved.

2. The local Military Sealift Command representative.

3. The vessel itself.

(2) *Using cargo data.*

(a) Table 2-4 shows a typical cargo list for a Victory vessel. Such a list provides data which must be compared with vessel capacity data.

Table 2-4. Cargo List

Belowdeck Cargo						
Amount	Supply class	Commodity	Weight (long tons)	Cubic feet	Cargostowage factor	Measurement tons
28,846 cases	CL I	C rations	666	40,961	62	1,024
6,996 cases	CL I	Powdered eggs	147	12,594	86	314.9
950 bags	CL I	Flour	64	3,006	47	75.1
3,816 drums	CL III	Diesel fuel	922	45,472	49	1,136.8
1,300 pallets	CL I	Palletized subsistence	1,508	90,980	60	2,274.5
11,628 cases	CL II	Clothing	223	29,070	130	726.8
3,212 pieces	CL IV	Steel plate	1,050	10,480	10	262
8 each	CL VII	Trk, cargo, 2½-ton, M35A2 WWN	49	9,878	201	246.9
8 each	CL VII	Tk, M60A1	349	26,954	77	673.7
1,500 boxes	CL IX	Repair parts	417	22,285	53	557.1
5,000 boxes	CL II	Publications and forms	307	17,806	58	445.2
5,000 boxes	CL VIII	Miscellaneous supplies	320	26,880	84	672
300 boxes	CL IX	Marine repair parts	270	26,250	97	656.3
1,800 boxes	CL II	Miscellaneous supplies	180	7,500	42	187.5
110 crates	AF	Aircraft parts	87	10,700	123	267.5
20,376 cases	CL VI	Beer	373	20,376	55	509.4
525 boxes	NAVY	General cargo	145	8,830	61	220.8
Total cargo below deck			7,074	410,022	58	10,250.5
Deck cargo						
16 each	CL VII	Trk, cargo, 2½-ton, 6X6, M34	98	19,756	201	493.9
18 each	CL VII	Trk, cargo, ¾-ton, M37B1 WWN	40	9,628	200	240.7
Total deck cargo			138	29,384		734.6
Total cargo			7,215	439,406		10,985.1

(b) The following is a comparison of the below deck vessel capacities listed in (1)(a)2 above with the total cargo being stowed below deck, as presented in table 2-4.

	Long tons	Cubic feet
Vessel capacity	8,425	456,525
Allowance for broken stowage (10 %)	-----	-45,652
Belowdeck capacity	8,425	410,873
Cargo allocated for loading below deck	-7,074	-410,022
Belowdeck capacity not used	1,351	851

(3) *Determining vessel stowage factor.*

(a) The VSF is determined by dividing the bale cubic capacity of the vessel (456,525 cubic feet) by the weight of the cargo to be loaded below deck (7,074 long tons), which in this case gives a VSF of 64.5.

(b) The VSF is used to distribute weight below deck (para 2-9).

(4) *Initial cargo allocation.*

(a) Cargo in long tons is initially allocated to compartments below deck by dividing the cubic capacity of each compartment by the vessel stowage factor, as shown in table 2-5.

Table 2-5. Weight Distribution

Hold	Cargo compartments	Capacities (cubic feet) 1/	Vessel stowage factor	Tons allocated
No. 1	Forecastle deck	22,045	64.5	339
	'Tween deck	23,785	64.5	369
	Lower hold	27,910	64.5	431
No. 2	Upper 'tween deck	27,010	64.5	417
	'Tween deck	21,805	64.5	337
	Lower hold	27,945	64.5	431
No. 3	Upper 'tween deck	45,555	64.5	700

Table 2-5. Weight Distribution—Continued

Hold	Cargo compartments	Capacities (cubic feet) ¹	Vessel stowage factor	Tons allocated
	Tween deck	37,795	64.5	589
	Lower hold	52,840	64.5	844
No. 4	Tween deck	49,200	64.5	699
	Lower hold	51,100	64.5	838
No. 5	Tween deck	43,630	64.5	674
	Lower hold	25,905	64.5	406
Total		456,525		7,074

¹ The capacities of the various compartments are found in the capacity tables for the particular vessel being loaded.

(b) The weight distribution plan (fig 2-22) may be used to show where cargo tonnages are allocated. Tentatively, the plan is to place nine ¾-ton trucks (24 L/T) on hatch No. 2, nine ¾-

ton trucks (24 L/T) on hatch No. 5, eight 2½-ton trucks (49 L/T) on hatch No. 3, and eight 2½-ton trucks (49 L/T) on hatch No. 4.

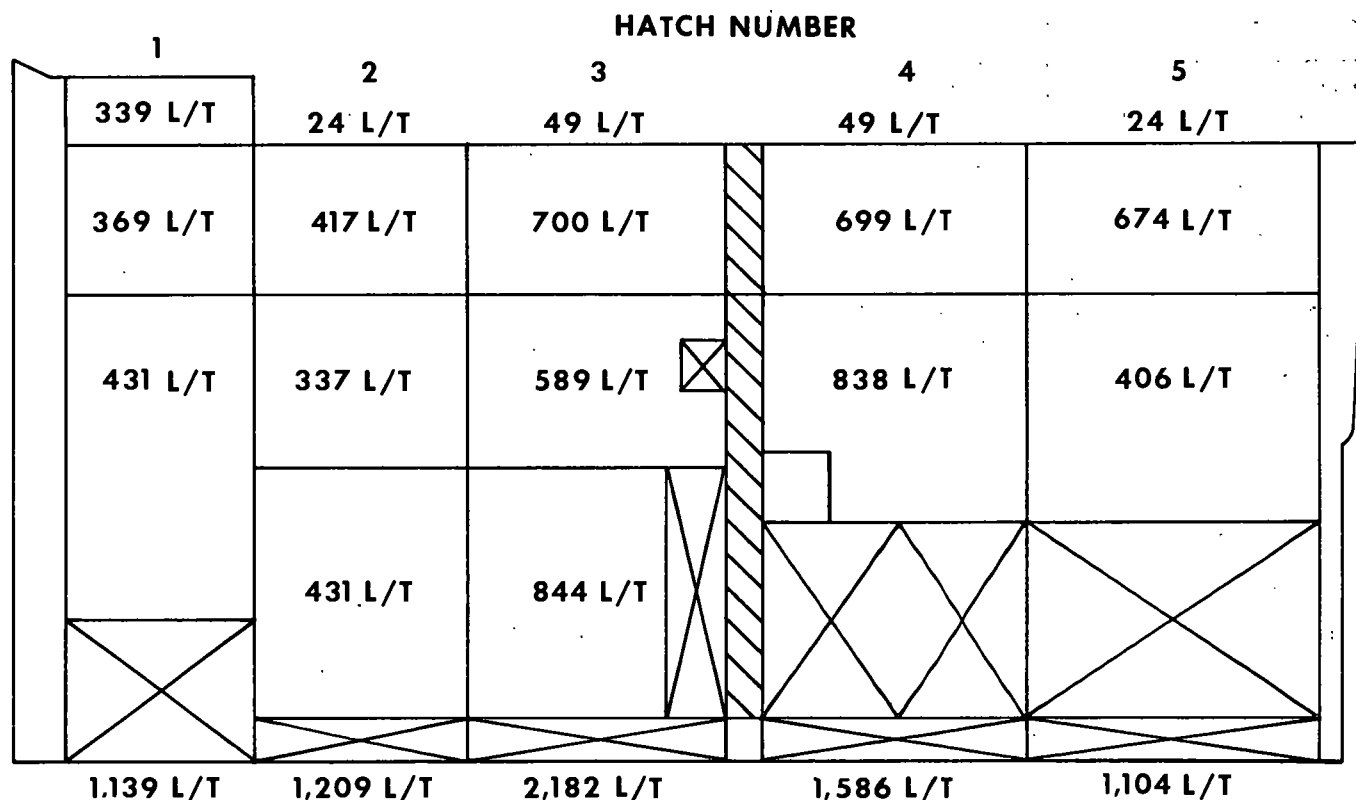


Figure 2-22. Weight distribution plan.

(5) *Determining the vessel's trim.*

(a) To insure that the distribution of weight as indicated in figure 2-22 will give the proper drag, a table (table 2-6) is prepared to estimate the loaded trim. The method used here for estimating trim is based upon the assumption that all fuel, water, and stores necessary for this

voyage are on board when the vessel arrives, and the arrival draft is 9 feet forward and 18 feet 8 inches aft.

(b) If additional fuel, water, and stores are required before sailing, their weight and location should be included when estimating the loaded trim.

Table 2-6. *Estimating Trim (20-Foot Table)*

	Tonnage (long tons)		Immersion per 100 long tons (scale from fig 2-21):	Forward action (inches) (+) (-)		Aft reaction (inches) (+) (-)	
Hold 1	1,144	x	forward (inches) +9.6 aft (inches) -5.8	109.8		66.3	
Hold 2	1,214	x	+7.2 -3.2	87.4		38.8	
Hold 3	2,160	x	+4.3 -0.2	92.8		4.3	
Hold 4	1,604	x	-2.5 +6.9	40.1 110.6			
Hold 5	1,101	x	-5.9 +10.4	64.9 114.5			
				Total +290.0 -105.0 +225.1 -109.4			
290.0 in -105.0 = 185.0 in (15 ft 5 in) forward immersion ;							
225.1 in - 109.4 in = 115.7 in (9 ft 8 in) aft immersion							

Arrival
Immersion
Sailing
Drag on sailing

Draft

9 ft forward, 18 ft 8 in aft, 13 ft 10 in. mean (from fig. 2-23)
15 ft 5 in. forward, 9 ft 8 in. aft
24 ft 5 in. forward, 28 ft 4 in. aft, 26 ft 5 in. mean
3 ft 11 in.

(6) *Prestowage plan (fig 2-23)*. A plan must be prepared showing where the cargo will be loaded. This prestowage plan (also called the loading plan) is tentative and may be changed several times before or during actual loading. The prestowage plan must be prepared before any cargo is loaded. It should show the distribution of cargo throughout the cargo compartments in a

manner which prevents undue strain on any portion of the vessel. The cargo should be stowed so that the vessel will be stable and correctly trimmed. The prestowage plan provides a basis for scheduling the arrival of cargo shipside according to priority and for estimating requirements for cargo handling equipment.

(a) Analysis of cargo. Of the commodities listed in table 2-4, the following types require special attention:

1. Heavy lifts.

8 M60A1 tanks 43.5 long
tons each

24 M3582 2½ ton,
6x6 cargo trucks . . 6.1 long tons
each

A check of the boom capacities will show that a 50-ton jumbo boom located forward at hatch No. 3 can handle the tanks. Since the two sets of 5-ton booms located forward and aft at hatches Nos. 3 and 4 can be double rigged, the trucks can be handled at these hatches without the jumbo booms.

2. *Weight cargo.* Weight cargo or bottom cargo is cargo suitable for bottom stowage in the lower holds or 'tween decks. As a rule, the stowage factor of weight cargo is lower than the vessel stowage factor. The following items and respective dimensions are examples of weight cargo:

	<i>Long tons</i>	<i>Cubic feet</i>
Steel plates	1,050	10,480
Diesel fuel	922	45,472
Miscellaneous supplies . . .	180	7,500
Repair parts	417	22,285
*Palletized subsistence	1,508	90,980

3. Filler cargo. Filler cargo is normally used to prevent or help reduce broken stowage during transport. It consists of small durable packages or pieces of cargo that may be stowed in the spaces between larger pieces. Filler is also the term applied for small cargo used to reduce the space above larger packages where headroom is restricted or where space is irregular and limited. When small packages are used to fill the spaces between larger pieces, the smaller packages must not be subjected to undue pressure, dragging, or possible damage. Dunnage and blocking material should be used to prevent this type of damage. The following items and their respective dimensions are examples of filler cargo:

	Long tons	Cubic feet
C rations	666	40,961
Miscellaneous medical supplies	320	26,880
PX beer	373	20,376
AG publications	307	17,806
Baled clothing	223	29,070

(b) **Specific allocation of cargo.** Using the data found in a weight distribution plan (e.g., fig 2-22) and the cubic capacities of the compartments, cargo can be allocated to specific compartments.

1. The following factors should be considered when allocating cargo:

(a) Allowance for broken stowage is deducted from each compartment. In this example, 10 percent is used.

(b) Cargo is allocated by weight and cubic capacity to insure that the maximum space is used.

(c) Where possible, like items are stowed together to reduce delay in discharging and error in checking.

(d) Heavy lifts are placed within reach of proper booms, except when instructions have been received that the discharging port will furnish equipment for discharging heavy lifts.

(e) Items of other services (Navy, Air Force, etc.) are kept together if possible.

(f) Items requiring special handling, such as mail or post exchange or security cargo, are stowed in a safe place.

(g) The weight limitations per square foot must not be exceeded.

2. In table 2-4 cargo was allocated to each compartment using the vessel stowage factor (64.5). However, this factor does not make an allowance for broken stowage; the compartment stowage factor is used for this purpose. To find the compartment stowage factor, the allowance for broken stowage (10 percent in this example) is subtracted from the cubic volume of each compartment and the difference divided by the weight allocated to it (table 2-5). Another method is to deduct 10 percent from the vessel stowage factor, which in this case produces a compartment stowage factor of 58.0

3. In loading general cargo, the cargo stowage factors will differ widely, and it will be necessary to load more than one commodity in a compartment to obtain the proper ratio between weight and space.

(a) The weight, or bottom cargo, should first be distributed in the hold of the vessel. Then, heavy lift cargo should be placed in a location where the jumbo boom can be used.

(b) The cargo stowage factor is used to allocate general cargo to compartments. To determine the space required to load several commodities in one compartment, the number of tons of each commodity is multiplied by its stowage factor.

(c) If there is still space in the compartment for additional cargo, the topping-off formula will help the planner to fill the unused space. This formula may be used with two commodities, one having a larger and one a

smaller stowage factor than the stowage factor of the space to be filled. The number of long tons of the lighter commodity (that commodity having the higher stowage factor) to be stowed is determined from the formula—

$$X = \frac{V - AT}{B - A}$$

where—

X = long tons of the lighter commodity to be stowed

V = net cubic capacity of space to be filled (taking into account broken stowage)

A = stowage factor of the denser commodity

T = tonnage capacity of space to be filled

B = stowage factor of the lighter commodity

For example if—

V = 22,030 cubic feet

A = 30

T = 475 long tons

B = 55

then—

$$\frac{22,030 - 30(475)}{55 - 30} = \frac{22,030 - 14,250}{25} =$$

$$\frac{7,780}{25} = 311 \text{ long tons of the lighter commodity}$$

Since the tonnage capacity of the space to be filled is 475 long tons, the remaining space will be filled with 164 long tons of the denser commodity.

(c) Adjusted trim. It will be noted that the

weights as allocated and shown in figure 2-23 do not coincide with the weights shown in figure 2-22. This is because of the physical characteristics of the cargo. Using the trim table (fig 2-21) and the estimated trim table (table 2-6), the drag is adjusted to reflect the new distribution of weight. In this case the drag is decreased by 1 inch; it is now 3 feet 10 inches.

(d) Cubic capacity maximization. When allocating cargo to insure maximum use of the cubic capacity of the compartment, the size of the cargo, the size of the hatches, and the overhead clearance must be considered. This is illustrated by an analysis of No. 4 lower hold in figure 2-23. The cargo planner allocated enough steel plates and C rations to build a level floor of cargo 3 feet 6 inches high. He allowed 4 additional inches for dunnage and stowed the eight cargo trucks on top of this floor, putting four trucks in the aft end of the hatch and two in each wing. The trucks were secured, and baled clothing was stowed in the trucks. Bulkheads were then built on the inboard sides of the trucks in the wings and forward of the trucks in the aft end. General supplies were then stowed in the remaining space on top of the dunnage and topped off with the remainder of the baled clothing. No. 4 lower hold has 10 feet 10 inches clearance; 3 feet 6 inches of cargo, plus 4 inches of dunnage, plus 6 feet 10 inches of cargo, uses 10 feet 8 inches of this clearance and makes maximum use of the cubic capacity of the compartment.

b. Data and capacities cited and assumptions made in this section of this chapter are for a standard five-hatch Victory ship.

Section IV. CARGO RECEIPT AND SPECIFIC LOAD PLANNING

2-13. Delivering Cargo to Shipside

Efficient pier operation requires the continuous movement of cargo. Bottlenecks created by wharves filled to capacity or badly congested with loaded vehicles seriously retard the loading of vessels and greatly reduces port efficiency.

a. Cargo is normally delivered to the port by railroad cars, lighters, and trucks. Heavy lift cargo is usually scheduled for delivery at a specified time and place in order to effectively coordinate the use of heavy lift equipment.

b. The usual procedure, after the date and hour have been determined for the vessel to start

loading, is to have the bottom cargo called forward and made available before the vessel is ready to start loading. Filler cargo is also assembled on the pier to be used as needed.

2-14. Loading Time

Many factors can affect the loading time of conventional ships.

a. Port speed in handling break-bulk cargo varies as much as 25 to 30 percent. Within ports themselves, one section may perform as much as 20 percent more efficiently than another. It is necessary to be familiar with the labor produc-

tivity in a locality to estimate loading time with any degree of accuracy.

b. If the cargo were distributed equally in each hold and the tons handled per hour for all commodities were constant, estimating the working time would be relatively easy and accurate. However, these ideal conditions do not exist.

(1) The standard five-hatch Victory vessel cited in this example has the following weight distribution in long tons:

Hatch No. 1	1,139
Hatch No. 2	1,209
Hatch No. 3	2,182
Hatch No. 4	1,586
Hatch No. 5	1,104

(2) Since the rate of loading varies with each commodity, a knowledge of these rates at a particular port is necessary before loading time can be predicted accurately. To determine the time required to load the vessel cited in this example, the loading rates in table 2-7 are to be used. However these rates are used only to illustrate one method of estimating loading time. Loading rates can be used to estimate loading time for each commodity, as shown below:

$$\frac{\text{L/T of cargo to be loaded in a hatch}}{\text{hourly loading rate}} = \frac{\text{hours required}}{\text{for loading}} \times \frac{60}{\text{minutes}}$$

= total minutes required for loading

Example (information from tables 2-7 and 2-8, No. 1 hatch):

$$\frac{373 \text{ L/T of beer}}{20 \text{ L/T per hour}} = 18.65 \text{ hours} \times 60 \text{ minutes} \\ = 1,119 \text{ minutes required for loading}$$

c. The following factors should also be considered:

- (1) Time required for rigging and rerigging.
- (2) Time required for handling dunnage.
- (3) Time required for blocking and lashing.
- (4) Time required for opening and closing hatches.

(5) Time required for shifting the vessel or lighters (should this be necessary).

d. Using the loading rates in table 2-7, the loading time can be calculated as shown in tables 2-8 and 2-9.

Table 2-7. Loading Rates

Commodity	Long tons per hatch-season hour
Tanks, M60A1	90
Trucks, ¾-ton	25
Trucks, 2½-ton	25
General cargo	15
C rations	20
Beer	20
Palletized subsistence	25
Steel plate	10
Powdered eggs	10
Baled clothing	9
Drummed fuel oil	20
Flour	20

Table 2-8. Estimating Loading Time—Initial Calculations

Cargo or operation	Minutes
<i>No. 1 hatch</i> (one hatch section)	
Rigging and opening (forecastle deck, 'tween deck, and lower hold)	100
Handling dunnage	30
Loading 373 long tons of beer	1,119
Loading 58 long tons of powdered eggs	348
Closing lower hold, preparing 'tween deck	45
Loading 98 long tons of general cargo	392
Loading 133 long tons of palletized subsistence	319
Loading 89 long tons of powdered eggs	534
Loading 49 long tons of flour	147
Closing 'tween deck, preparing forecastle deck	45
Loading 339 long tons of general cargo	1,356
Handling dunnage throughout loading	60
Closing forecastle deck, swinging in gear, and placing tarpaulin on hatch	30
Total	4,525
or	
$\frac{4,525}{60} = 75 \text{ hours } 25 \text{ minutes}$	

Table 2-8. Estimating Loading Time—Initial Calculations—Continued

Cargo or operation	Minutes
--------------------	---------

No. 2 hatch
(one hatch section)

Rigging and opening (upper 'tween deck, 'tween deck, and lower hold)	100
Handling dunnage	30
Loading 140 long tons of steel plate	840
Loading 94 long tons of diesel fuel	282
Loading 197 long tons of general cargo	788
Closing lower hold, preparing 'tween deck	45
Loading 250 long tons of diesel fuel	750
Loading 87 long tons of general cargo	348
Closing 'tween deck, preparing upper 'tween deck	45
Loading 175 long tons of general cargo	700
Loading 199 long tons of palletized subsistence	478
Loading 43 long tons of C rations	129
Handling dunnage throughout loading	60
Closing upper 'tween deck, preparing deck for deck cargo	45
Loading 24 long tons of ¾-ton trucks	58
Blocking, lashing, and swinging in gear	90
Total	4,788

or

$$\frac{4,778}{60} = 79 \text{ hours } 48 \text{ minutes}$$

No. 3 hatch
(two hatch section)

Rigging and opening (upper 'tween deck, 'tween deck, and lower hold)	85
Handling dunnage	30
Loading 325 long tons of steel plate	975
Rigging jumbo boom	40
Loading 349 long tons of tanks	233
Securing jumbo boom, rigging ordinary booms, and securing tanks	260
Loading 70 long tons of general cargo	140
Loading 100 long tons of baled clothing	333
Closing lower hold, preparing 'tween deck	45
Loading 25 long tons of steel plate	75
Loading 325 long tons of palletized subsistence	390
Loading 15 long tons of flour and 224 long tons of C rations	359
Closing 'tween deck, preparing upper 'tween deck	45
Loading 210 long tons of general cargo	420
Loading 440 long tons of palletized subsistence	528
Loading 50 long tons of C rations	80
Closing upper 'tween deck, preparing deck for deck cargo, rigging booms (block in bight)	60
Handling dunnage throughout loading	30
Loading 49 long tons of 2½-ton trucks	118
Blocking, lashing, and swinging in gear	120

Total 4,366

or

$$\frac{4,366}{60} = 72 \text{ hours } 46 \text{ minutes}$$

No. 4 hatch
(two hatch sections)

Rigging and opening ('tween deck and lower hold)	80
Handling dunnage	30
Loading 385 long tons of steel plate	1,155
Loading 275 long tons of C rations	413
Loading 32 long tons of general cargo	64
Rigging booms (block in bight)	30
Loading 49 long tons of 2½-ton trucks	118
Rerigging, blocking and lashing trucks, constructing and placing bulkheads	200
Loading 97 long tons of baled clothing	323

Table 2-8. Estimating Loading Time—Initial Calculations—Continued

Cargo or operation	No. 4 hatch—continued (two hatch sections)	Minutes
Closing lower hold, preparing 'tween deck		45
Loading 136 long tons of general cargo		272
Loading 411 long tons of palletized subsistence		493
Loading 55 long tons of general cargo		110
Loading 26 long tons of baled clothing		87
Loading 71 long tons of C rations		107
Closing upper 'tween deck, preparing deck for deck cargo, rigging booms (block in bight)		60
Handling dunnage throughout loading		30
Loading 49 long tons of 2½-ton trucks		118
Blocking, lashing, and swinging in booms		120
Total		3,855
or		
$\frac{3,855}{60}$	= 64 hours 15 minutes	

No. 5 hatch (one hatch section)		
Rigging and opening ('tween deck and lower hold)	80	
Handling dunnage	30	
Loading 175 long tons of steel plate	1,050	
Loading 84 long tons of diesel fuel	252	
Loading 147 long tons of general cargo	588	
Closing lower hold, preparing 'tween deck	45	
Loading 494 long tons of diesel fuel	1,482	
Loading 180 long tons of general cargo	720	
Closing 'tween deck, preparing deck for deck cargo	45	
Handling dunnage throughout loading	60	
Loading 24 long tons of ¾-ton trucks	58	
Blocking, lashing, and swinging in gear	90	
Total	4,500	
or		
$\frac{4,500}{60}$	= 75 hours	

Table 2-9. Estimating Loading Time—Final Calculations

Hatch	Total hours required	Gang-hours required	Average long tons per hatch-hour	Average long tons per gang-hour
1	75 hr 25 min	75	15	15
2	79 hr 48 min	80	15.1	15.1
3	72 hr 46 min	146	29.6	14.8
4	64 hr 15 min	128	24.7	12.35
5	75 hr	75	14.7	14.7
Total	367 hr 14 min	504	19.8	14.4

e. By examining the results of the calculations, certain conclusions can be made. Hold No. 2 will be the "long" hatch because it requires more hours to complete than the others. Hold No. 4 will be the "short" hatch. Labor gangs can be scheduled in such a manner that all hatches will be completed at about the same time. Constant checks must be made during loading to prevent delays and to insure that the planned tonnages are actually being loaded.

f. The times given in tables 2-8 and 2-9 apply

to the time required to load the vessel. Delays caused by equipment breakdown, foul weather conditions, and failure of cargo to arrive as scheduled should be added to the predicted loading time. If the hatches must be closed and opened again between shifts, the estimated time must be increased accordingly.

2-15. Final Stowage Plan (fig 2-24)

After the vessel has been loaded, a final stowage plan is prepared showing the actual location of the

cargo on the ship. Theoretically, the final stowage plan should agree with the prestowage plan, but this is seldom the case. In this example, they do

agree although the final stowage plan is more detailed.

Section V. DISCHARGE PLANNING

2-16. General

During discharge, cargo must be unloaded from the vessel, segregated, and placed aboard the mode of transportation that will move it to its destination. Since it is desirable to make maximum use of berthing space, planning for the discharge and movement of cargo should begin upon receipt of the ship's papers (stowage plan and ocean manifest) and the cargo disposition instructions. Planning includes a determination of—

- a. Point of discharge—wharf or anchorage.
- b. Operating unit or units to be used—terminal service company, amphibian company, boat company, etc.
- c. Special equipment required for special or heavy lifts.
- d. Priority of discharge, if any.
- e. Arrangements for terminal clearance, including transportation required, depot capability to receive, and necessity for further segregation.
- f. Cargo documentation and personnel required to accomplish it.

2-17. Discharge Over Wharves

When wharf discharge is being planned, consideration should be given to unloading the cargo onto the wharf or into lighters or a combination thereof. Plans should include the use of Army personnel and ship's gear, but allowances can be made for the use of other equipment and local civilian labor when available. Possible delays caused by weather, enemy action, etc., should also be considered.

a. *Wharf Requirements for Alongside Discharge.* For planning purposes, 100 feet of wharf length is required for each ship's hatch. The water depth alongside the wharf should be sufficient to insure a minimum of 2 feet of water between the ship's keel and the bottom at low tide. The water depth requirement will vary from 30 feet to 50 feet depending upon the size and draft of the vessel to be berthed.

b. *Lighter Discharge.*

(1) Ship-to-lighter discharge may be required for one or more of the following reasons:

- (a) To permit simultaneous discharge on both sides of vessels.
- (b) To prevent rehandling of cargo that is to be cleared from the terminal by inland waterway.
- (c) To lighten heavily laden vessels in deepwater anchorages so that they may be ac-

commodated at shallow depths alongside berths for further discharge.

(d) To fully discharge vessels in the anchorage area when wharf facilities are inadequate.

(e) To receive heavy lifts discharged by floating cranes.

(2) Practically any wharf may be used for lighter discharge. Wharves from which the water recedes at low tide may be used by berthing the lighters during high tide and discharging them during low tide. For discharging on one side only, a minimum wharf width of 35 feet is recommended; for discharging on both sides, 45 feet.

2-18. Berth Assignment

Factors to be considered in berth assignment are—

- a. Destination of cargo.
- b. Type of cargo.
- c. Capability of discharge points to handle cargo.
- d. Capability of wharf facilities for clearing cargo from discharge point to destination, including segregation if required.
- e. Capability of wharf to accommodate vessel: draft, beam, and length of vessel; working space on the wharf.
- f. Types of discharge operations: ship to wharf or ship to lighter to wharf.
- g. Modes of inland transportation available.
- h. Projected shipping schedule and other ship estimated times of arrival for the next several days.

2-19. Equipment Requirements

The cargo stowage plan and other ship's papers should be studied to determine requirements for special equipment. Deck cargo should be discharged as soon as the vessel arrives. Special cranes, floating or shorebased, may be required to discharge deck cargo; barges or lighterage equipment may be needed to move it from shipside. A careful study of the ship's papers before the ship arrives will enable the operations personnel to schedule this equipment so that it will be available at the time and place required. Requirements for cargo handling equipment, such as slings, bridles, snatch blocks, conveyors, box hooks, and other similar equipment should be determined by supervisory personnel (platoon leader, hatch foreman, etc.) in time to have it on hand when needed.

2-20. Transportation Requirements and Cargo Clearance

Information found in the ship's papers and the cargo disposition instructions will enable operations personnel to plan the transportation requirements for cargo clearance. The terminal commander is responsible for the segregation of cargo and its clearance from the water terminal. The importance of prompt clearance cannot be overemphasized.

a. The most efficient method of clearance is to discharge cargo directly from ship to the terminal clearance carriers' equipment. This does not necessarily mean direct discharge from cargo hook to clearance mode, though this method would be most desirable. Materials handling equipment should be used to move cargo from the

end of the ship's tackle to the clearance carrier whenever the operation can be speeded up by this method.

b. Operating conditions do not always permit direct clearance; for example, cargo may be so mixed that to segregate it during discharging would seriously delay operations. Special situations may require timely segregation of cargo by items, commodity digit numbers, or lot. Suitable clearance conveyances may not be available; receiving installations may be unable to accept cargo promptly; there may be delays or changes in the cargo disposition instructions. When such conditions exist, cargo may be moved to temporary storage areas for segregation and subsequent shipment.

CHAPTER 3

RIGGING AND OPERATING SHIP'S GEAR

Section I. GENERAL

3-1. Common Nautical Terms

In order to properly function aboard ship, personnel must know basic ship terminology. Below is a list of general terms not otherwise defined in this manual's specific subject areas.

- a. *Aboard* means on or within the vessel.
- b. An *adrift* ship is free of moorings, not under power or control.
- c. *Aft* is near, toward, at, or in the stern of a vessel.
- d. *After peak* is the compartment or tank between the last watertight bulkhead and the stern.
- e. *Aloft* means above the deck, normally referring to an individual going up into the rigging.
- f. *Amidship* is in the vicinity of the center of a vessel on the longitudinal or lateral axis.
- g. *Athwart* is that position which is at right angles to the fore and aft axis of the vessel; i.e., from side to side.
- h. *Beam* can mean—
 - (1) An athwartship horizontal member supporting a deck.
 - (2) The extreme width of the vessel.
- i. The *bilge* is any space in the lower part of the ship's hold where waste water collects and in which suction is placed for pumping waste out.
- j. *Boatswain* (Bos'un) refers to the senior nonofficer on deck responsible for all ship's equipment used by stevedores.
- k. The *bow* is the foremost point of the vessel.
- l. The *davit* is a device normally used to raise and lower a vessel's lifeboats.
- m. *Forward* (For'ard) is near, at, or toward the bow of the vessel.
- n. The *hatch* or *hatchway* is an opening in the deck of the ship to afford passage up and down.

o. The *hold* is the interior of a vessel where the cargo is stowed.

p. *Lee* is the side opposite that from which the wind blows.

q. The *length overall* of a vessel is measured in feet between perpendiculars; i.e., from the foremost point (bow) to the aftermost point (stern) of a vessel's hull.

r. *Port* is the left side of a vessel when looking forward toward the bow.

s. *Starboard* is the right side of a vessel when looking forward toward the bow.

t. The *stern* is the aftermost point of a vessel.

u. *'Tween deck* is any deck below the upper deck and above the lowest deck.

3-2. Fiber and Wire Rope Rigging

a. All military cargo handlers should have a basic knowledge of fiber and wire rope rigging as it applies to their duties. Appendix B of this manual covers the elements of this subject useful to the military cargo handler.

b. Additional information on minimum tread diameter of sheaves and drums, making knots and splices, construction, inspection, and care of wire rope may be found in TM 5-725.

3-3. Chains, Hooks, and Shackles

a. *Chain*. Chain is used in stevedoring operations for slinging loads and lashing cargo and as part of the ship's rigging.

(1) *Composition*. Chains are made up of a series of links fastened through each other. Each link is made of iron stock formed into an oval shape and welded at one or two points. The weld ordinarily causes a slight bulge on the side or end of the link (fig 3-1). The chain size refers to the diameter in inches of the rod used to make the link.

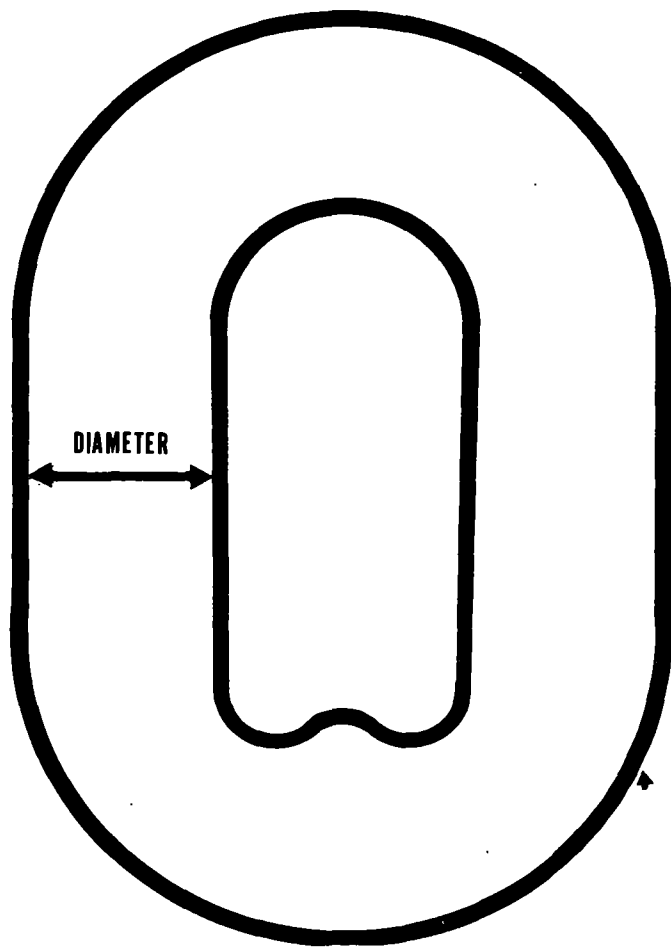


Figure 3-1. Chain link thickness.

(2) *Characteristics.* Chains will usually stretch under excessive loading, and the individual links will bend slightly. Bent links are a warning that the chain has been overloaded and might fail suddenly under load. If a chain is equipped with the proper hook, the hook should start to fail first, indicating that the chain is overloaded. Chains are much more resistant to abrasion and corrosion than wire rope; therefore, chains are used where this type of deterioration is a problem. For example, chains are used for anchor gear in marine work where the chains must withstand the corrosive effects of seawater. They are also used as slings to lift heavy objects with sharp edges which would cut wire. A number of grades and types of chain are available.

(3) *Strength.* Formulas for working with chain, along with those for numerous other elements of rigging gear, are given in paragraph B5, appendix B. The figures given there are based upon the assumption that the load is applied in a straight pull rather than by an impact. An impact load occurs when an object is dropped suddenly

for a distance and stopped. The impact load in such a case is several times the weight of the load.

(4) *Care.* When hoisting heavy metal objects using chains for slings, padding should be inserted around the sharp corners of the load to protect the chain links from being cut. The padding may be either planks or heavy fabric. Chains should not be permitted to twist or kink when under strain. Links of chain should never be fastened together with bolts or wire because such connections weaken the chain and limit its safe working capacity. Worn or damaged links should be cut out of the chain and replaced with a cold shut link. The cold shut link must be closed and welded to equal the strength of the other links. Small chain links can be cut with a bolt cutter. Large chain links must be cut with a hacksaw or oxyacetylene torch. Chains must be inspected frequently, depending on the amount of use. Painting a chain to prevent rusting is not advisable because the paint will interfere with the freedom of action of the links. A light coat of lubricant can be applied to prevent rusting. Chains should be stored in a dry and well ventilated place to prevent rusting.

b. Hooks. Chains, fiber rope, or wire rope can be tied directly to the load. However, for speed and convenience it is much better to fasten a hook to the lifting line. The hooks most frequently used in stevedoring are—

(1) *Cargo hooks.* Cargo hooks are shackled to the cargo runners for lifting and lowering drafts of cargo. Three principal types are used on American ships (fig 3-2).

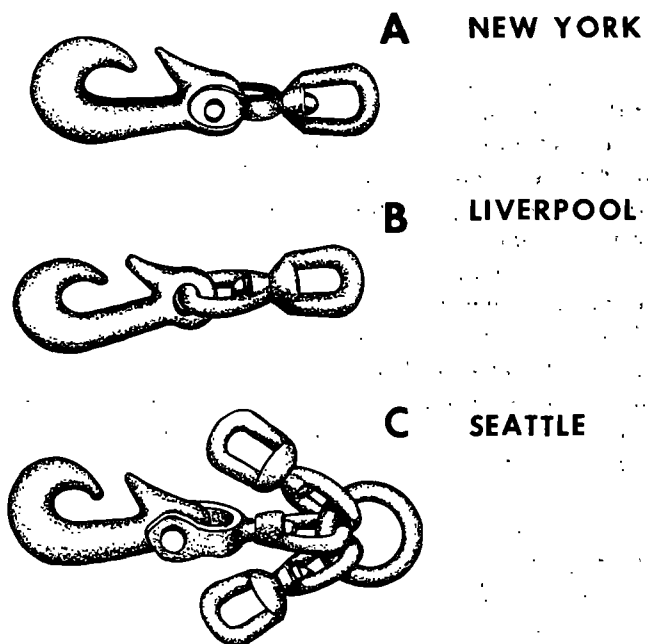


Figure 3-2. Types of cargo hooks.

(a) *New York*. The New York cargo hook is a drop-forged steel, self-colored hook, fitted with a jaw-and-eye swivel.

(b) *Liverpool*. The Liverpool hook is a drop-forged, self-colored steel hook, fitted with a double-eye swivel. This hook is included in the general hatch set and has a safe working load of 11,200 pounds.

(c) *Seattle*. The Seattle cargo hook is a drop-forged steel, self-colored hook, fitted with one jaw-and-eye swivel, two double-eye swivels, and a ring. It may also have a double-eye swivel in lieu of the jaw-and-eye swivel. This hook is

included in the general-hatch cargo set and has a safe working load of 11,200 pounds.

(2) *Hooks for slings*. Hooks can be used in conjunction with slings in many different ways. They can be shackled, moused or spliced into an eye, placed on the sling before the eyes have been spliced to permit the hook to slide, or used with chain slings. Two general types of hooks available for slings are the slip hook and the grab hook (fig 3-3). More specific types of sling hooks, in terms of tasks performed, are discussed in paragraphs 4-12 and 4-13.

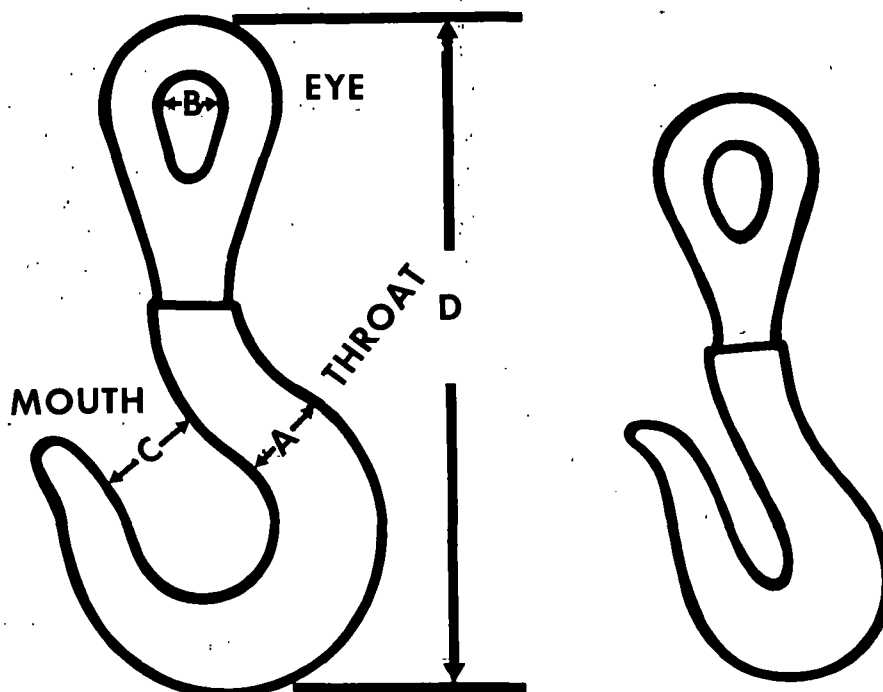


Figure 3-3. Types of hooks for slings.

(a) *Slip hooks*. These hooks are made so that the inside curve of the hook is an arc of a circle and may be used with wire rope, chains, and fiber rope. Chain links can slip through a slip hook so the loop formed in the chain will tighten under a load.

(b) *Grab hooks*. These hooks have an inside curve which is nearly U-shaped so the hook will slip over a link of chain edgewise but will not permit the next link to slip through. Grab hooks have a more limited range of use than slip hooks. They are used when the loop formed with the hook is not intended to close up around the load.

(c) *Strength of hooks for slings*. Hooks usually fail by straightening. Any deviation from the original inner arc indicates that the hook has been overloaded. Since evidence of overloading the hook is easily detected, it is customary to use

a hook weaker than the chain to which it is attached. With this system, distortion of the hook will occur before the chain is overloaded. Severely distorted, cracked, or badly worn hooks are dangerous and should be discarded. The safe working loads and breaking strengths of hooks for slings can be estimated using the formulas in paragraph B-5, appendix B. The diameter used in these formulas is the "throat" measurement shown in figure 3-3.

(d) *Mousing hooks for slings*. In general, sling hooks should always be "moused" as a safety measure to prevent slings or ropes from jumping off. Mousing, the binding of hemp or wire across the opening of a hook to prevent it clearing itself, also helps prevent straightening of the hook but does not strengthen it materially. To mouse a hook (fig 3-4) after the sling is on the

hook, wire or heavy twine is wrapped 8 or 10 turns around the two sides of the hook. The process is completed by winding several turns of the wire or

twine around the sides of the mousing and tying the ends securely.

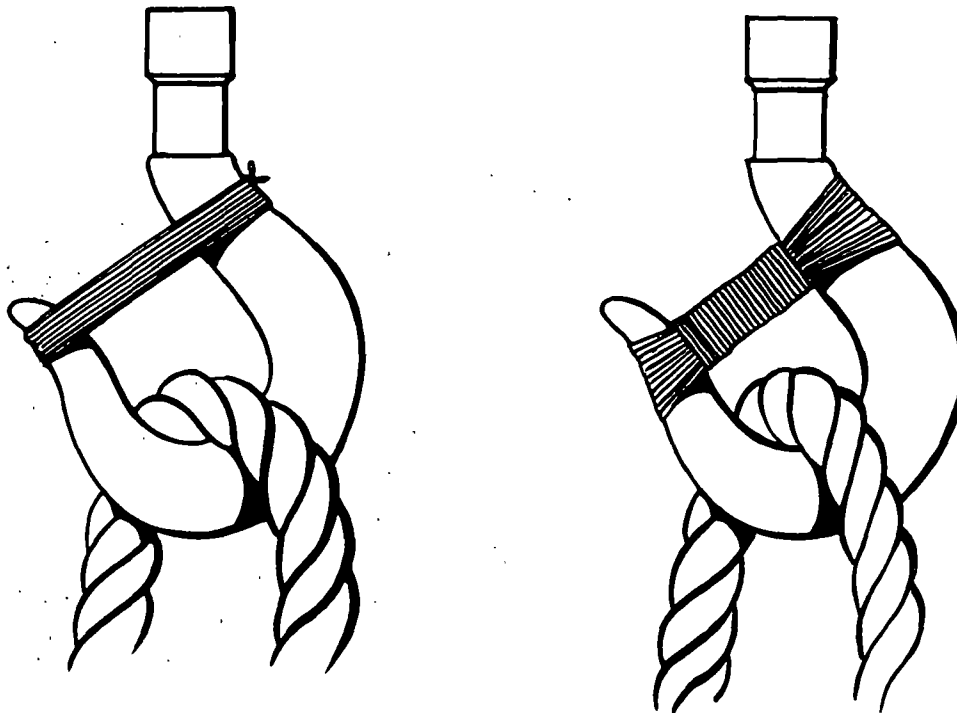


Figure 3-4. Mousing hooks.

c. *Inspection of Chains and Hooks.* Chains, including the hooks, should be inspected at least once a month, but those that are used for heavy and continuous loading require more frequent inspections. Particular attention must be given to the small radius fillets at the neck of hooks for any deviation from the original inner arc. Each link and hook must also be examined for small dents, cracks, sharp nicks or cuts, worn surfaces, and distortions. Those that show any of these weaknesses must be replaced. If several links are stretched or distorted, the chain should not be used because it probably was overloaded or hooked improperly which weakened the entire chain.

d. *Shackles (fig 3-5).* Anchor, antitoppling, and chain shackles are the principal type of shackles. Round, screw, and safety pins are the principal types of shackle pins. The following safety rules should be observed when using shackles:

(1) Pins must be straight.

(2) Screw pins must be screwed in all the way.

(3) Nuts on safety pins must be snug against the eye of the shackle and cotter pins inserted before the shackle is used.

(4) There must be no strain on the side of a shackle.

(5) Widths between the eyes must not be greater than they were originally. Excessive widths indicate that the shackle has been strained and should not be used.

(6) When shackles are placed under strain, the bearing surface of the sling or fitting being used should cover the entire bearing surface of the shackle pin. If the size of the sling or the size or design of the fitting makes this impossible, then another size shackle should be used. The formulas for estimating safe working loads and breaking strengths of shackles are found in paragraph B-5, appendix B and are valid only if the above safety rules are followed.

ANCHOR SHACKLES

CHAIN SHACKLES

ANTITOPPLING SHACKLES

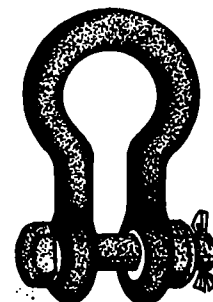
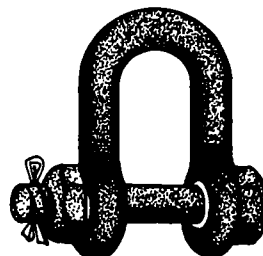
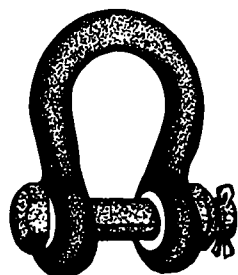
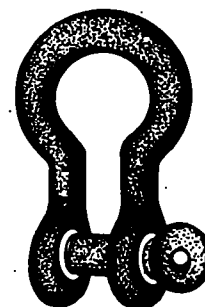
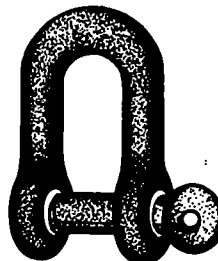
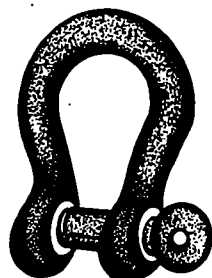
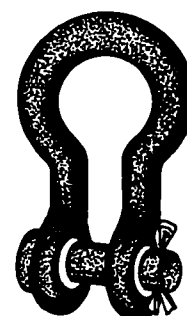
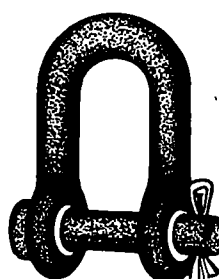
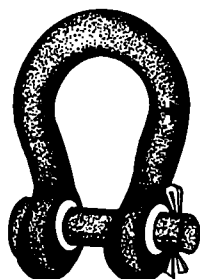
SAFETY
PINSCREW
PINROUND
PIN

Figure 3-5. Types of shackles.

3-4. Blocks and Tackle

Blocks and tackle that change direction of pull and increase pulling or lifting power are essential for moving, lifting, and stowing heavy cargo. Appendix B covers the elements of this subject ordinarily of use to the military cargo handler. TM 5-725 provides additional detailed in-

formation on the uses, types, and capabilities of various blocks and tackle.

3-5. Rigging and Deck Fittings

a. *Standing Rigging* (Fig 3-6). Standing rigging includes permanent and semipermanent structures and gear.

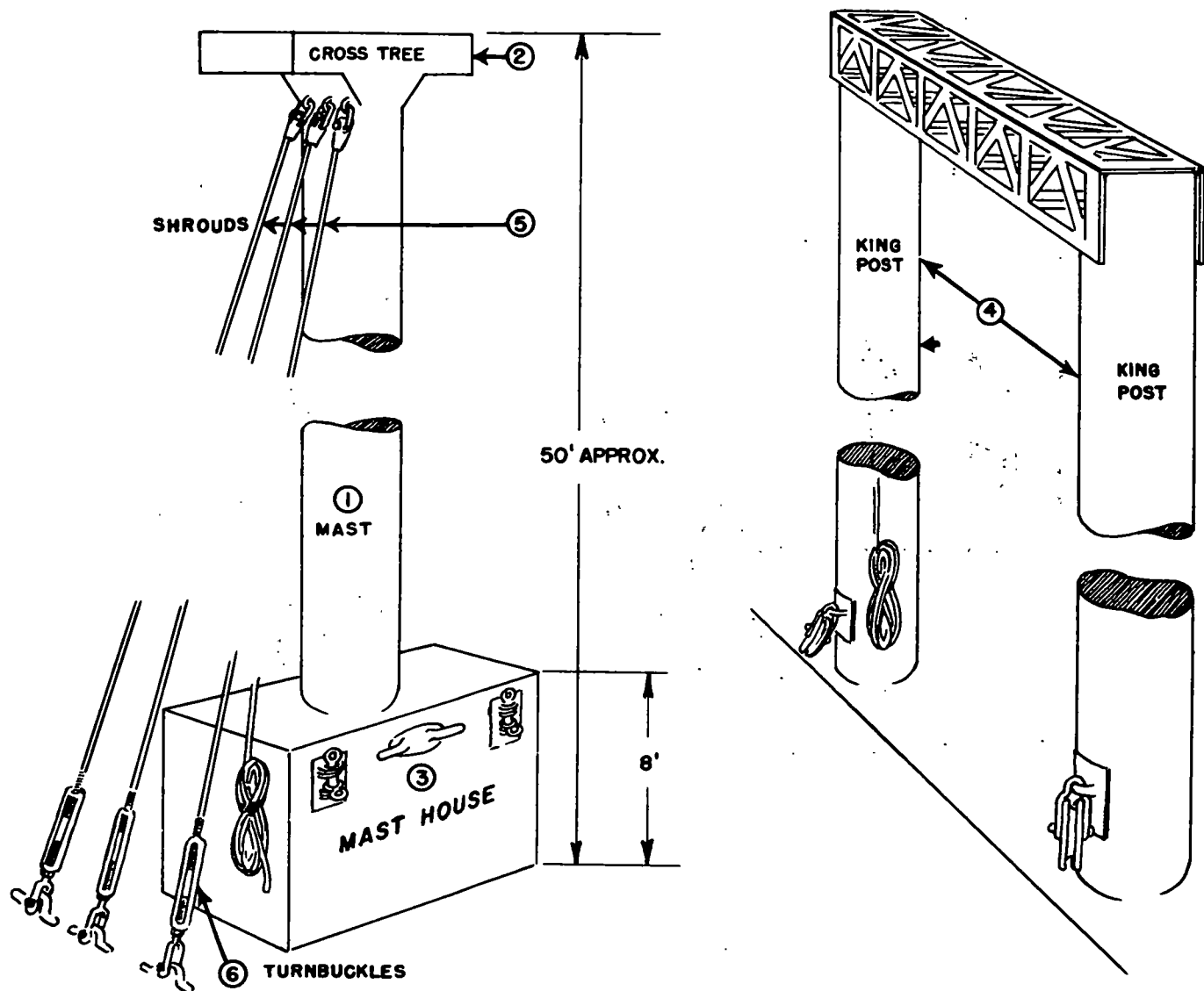


Figure 3-6. Standing rigging.

(1) The principal function of *masts* (1, fig 3-6) is to support cargo booms. Masts also support signal lights, antennas, and crow's nests. On most modern ships, each mast is fitted with a crosstree (2, fig 3-6), to which the topping lift blocks are secured, and a mast house (3, fig 3-6), which supports the heel of the boom.

(2) *King posts* (4, fig 3-6) are two vertical supports, usually steel, one on each side of the centerline of the ship used to support booms. King posts are also called Samson posts.

(3) *Shrouds* (5, fig 3-6) are heavy wire ropes that provide athwartship support for the mast or king posts. Two or more shrouds are used on either side of a mast or king post and are secured to the deck or bulwark in a fore and aft direction to provide maximum support.

(4) *Stays and backstays* are heavy wire ropes similar to shrouds, found at the mast where the jumbo boom is located. When they support the masts or king posts from a forward direction, they are called stays, and when they support from an aft direction, they are called backstays. Additional stays and backstays may have to be rigged when unusually heavy lifts are being loaded and discharged.

(5) *Turnbuckle* (6, fig 3-6) is an internally threaded collar turning on two screws threaded in opposite directions and is used to take up slack in the shrouds and stays.

b. Running Rigging (fig 3-7). Running rigging includes the moving parts of ship's gear.

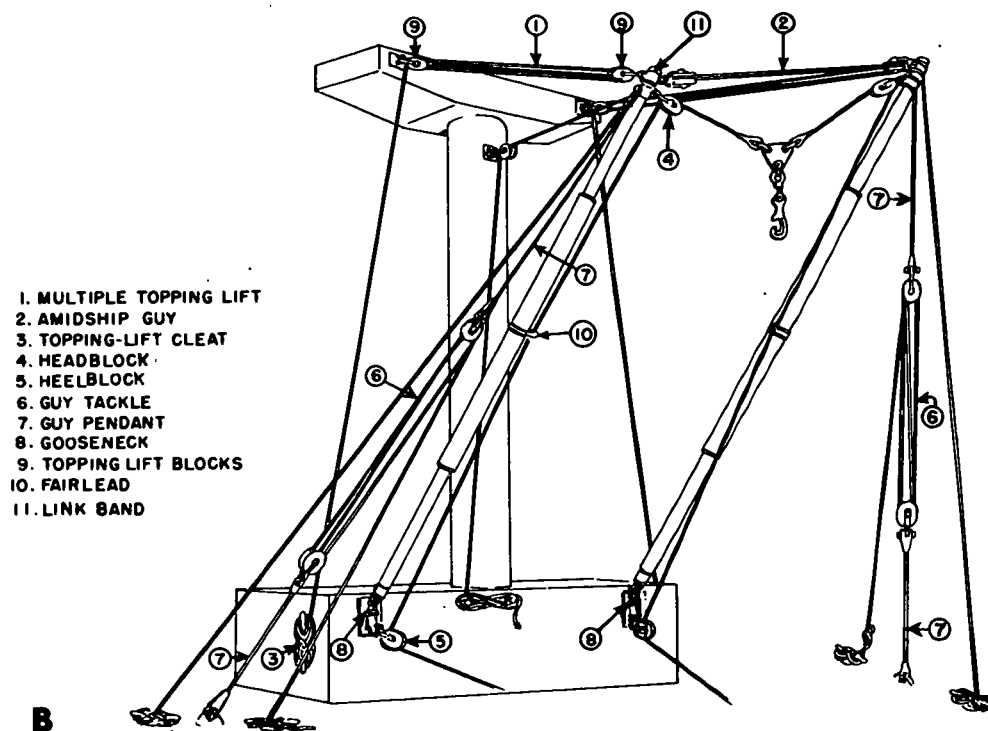
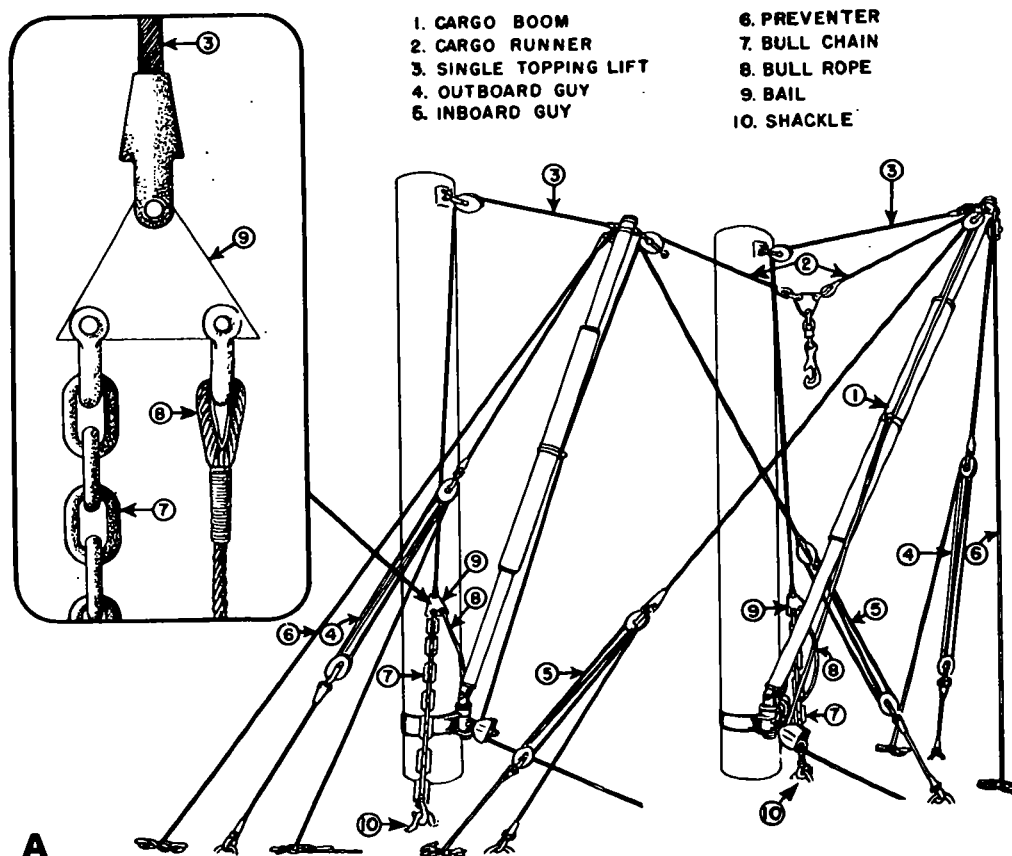


Figure 3-7. Running rigging.

(1) A *cargo boom* (1, A, fig 3-7) is a spar extending from a mast or a king post. It is used as a derrick arm to handle cargo. Booms are sometimes referred to as derricks.

(2) The cargo hoisting wire rope or line reeved through the boom blocks and used for working cargo is the *cargo runner* (2, A, fig 3-7). The runner is also called the *cargo fall* or *whip*.

(3) The tackle that raises and lowers the boom is the *topping lift*. *Single* (3, A, fig 3-7) and *multiple* (1, B, fig 3-7) *topping lifts* are used aboard ship.

(a) The single topping lift is a single wire rope $1\frac{1}{4}$ inches or larger running through a single-sheave topping-lift block at the cross-tree on the mast or at the top of the king post. One end is shackled to the head of the boom and the other to the bail.

(b) The multiple topping lift is a single wire rope reeved through a block at the head of the boom and a block at the masthead and made fast on the topping-lift cleat. The size of the wire depends on the safe working load of the boom, but $5/8$ - to $7/8$ -inch wire rope is usually used.

(4) The lines or tackles used to steady or swing booms are usually known as *guys*. When led to a source of power, however, *guys* are called *vangs*. *Outboard guys* are illustrated in 4, A, figure 3-7; *inboard guys* are illustrated in 5, A, figure 3-7. An *amidship guy* (sometimes called the *lazy guy* or the *schooner guy*) is illustrated in 2, B, figure 3-7.

(a) Outboard guys are made fast to the outboard side of the head of the boom and to fittings on the deck or bulwark. These guys are often referred to as the working guys because they are the ones under greatest stress. The stress on the guys appears when the load is being transferred athwartship or when it is being supported anywhere between the two boom heads.

(b) Inboard guys are made fast to the inboard side of the head of the booms and to fittings on the deck or bulwark. Since the load on the cargo hook is always between the heads of the two booms or directly under one of them, there is little or no stress on inboard guys.

(c) Amidship guys serve the same purpose as inboard guys—they hold the booms together. They have the advantage of being up and out of the way when both booms are being worked together. Amidship guys consist of a light tackle between the heads of the two booms. The hauling part of the tackle is usually led through a lead block on the mast or king post and made fast to a cleat.

(5) The *preventer* (6, A, fig 3-7) is a wire rope used in addition to the guys to reinforce against additional strain.

(6) The *bail* (topping-lift) (9, A, fig 3-7) is a triangular steel plate with a hole in each corner to which are attached the topping-lift wire, the bull chain, and the bull rope on a single topping lift.

(7) The *bull chain* (7, A, fig 3-7) is a heavy-duty chain having links $1\frac{1}{4}$ inches in diameter or larger. It is used on a single topping lift to hold the boom in its vertical working position.

(8) The *bull rope* (8, A, fig 3-7) is a wire rope used on a single topping lift to top and lower the boom.

(9) The *topping-lift cleat* (3, B, fig 3-7) is attached to the mast house or king post and is used for securing the multiple-topping-lift wire.

(10) The *headblock* (4, B, fig 3-7) is the block at the head of the boom through which the cargo runner is led to the cargo hook.

(11) The *heelblock* (5, B, fig 3-7) is the block at the heel of the boom through which the cargo runner is led to the winch.

(12) The *guy tackle* (6, B, fig 3-7) consists of the blocks and tackle used on guys.

(13) The *guy pendant* (7, B, fig 3-7) is a short wire rope with a thimble or socket on each end. Guy pendants are used to attach the guy tackle to the head of the boom and to the deck or bulwark.

(14) The *gooseneck* (8, B, fig 3-7) is a metallic swivel joint that connects the heel of the boom with the mast or the mast house.

(15) *Topping-lift blocks* (9, B, fig 3-7) are blocks at the head of the boom, the crosstree on the mast, or the top of the king posts through which the topping-lift wire is reeved.

(16) A *fairlead* (10, B, fig 3-7) is a block, ring, or strip of plank with holes, serving as a guide for the running rigging or any rope to keep it from chafing and as a direct line to a source of power.

(17) The *link band* (11, B, fig 3-7) is a band around the head of the boom to which the topping-lift guys and head blocks are secured.

(18) The *stopper chain* is a piece of close-link chain about 6 feet long composed of links $\frac{1}{4}$ to $\frac{1}{2}$ inch in diameter. It is used to stop off the multitopping-lift wire when transferring the wire from the cleat to the winch and vice versa.

c. *Deck Fittings* (fig 3-8). Deck fittings include the devices used to secure standard and running rigging.

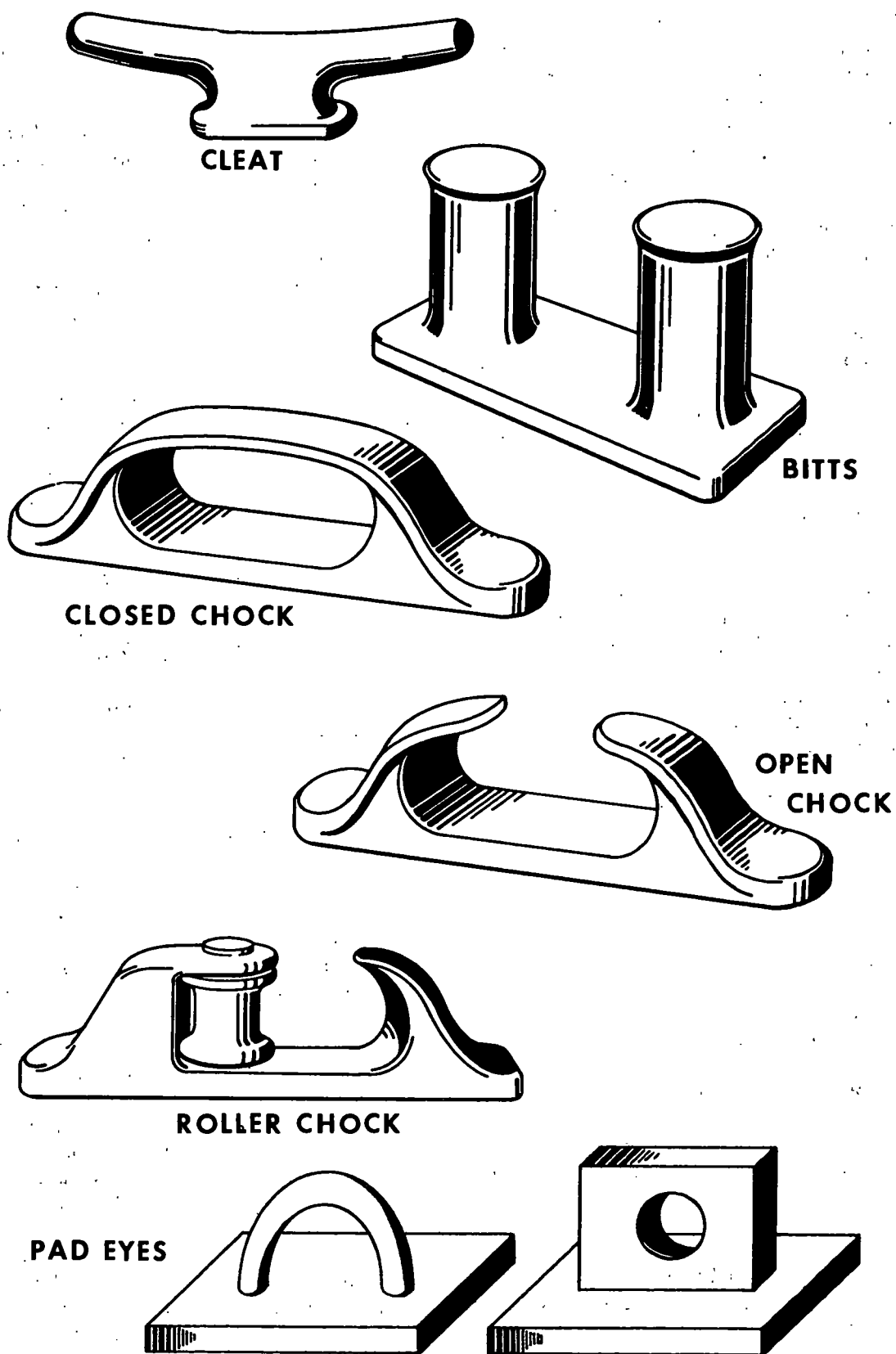


Figure 3-8. Deck fittings.

(1) *Bitts* are heavy devices with a bed plate and two iron or steel posts, used on ships for securing mooring or towing lines.

(2) *Chocks* are heavy fitting secured to the deck, used for the lead of lines. Types of chocks are closed, open, and roller.

(3) *Cleats* are metal fittings having two projecting horns welded to a vessel's deck and used for securing lines.

(4) *Pad eyes* are fixtures attached to a deck

or bulkhead, having an integral base plate and an eye to which lines or tackle may be fastened for securing or hauling cargo.

(5) *Cleats and pad eyes* are often attached to the bulwark. The bulwark consists of a raised plating along each side of the vessel above the weather deck. The plating is covered by a bulwark rail, which serves as a stiffener for the upper edge of the plating.

Section II. WINCHES

3-6. Cargo Winches

Cargo winches are the source of mechanical power in stevedoring operations. They are power-driven machines used to lift, lower, or move cargo. Winches are classified according to their source of power: steam, electric, or hydraulic.

a. Steam winches are still in use on ships; however, most ships use electric winches.

(1) Types of steam winches are described below.

(a) The reverse-valve type is one basic type of steam-powered cargo winch. If a winch operator understands the operating principles of this winch, he can quickly adapt to the operation of the other types.

(b) The friction winch is driven by a cone friction band instead of gears. It is efficient for handling light drafts.

(c) The reverse-link winch has a keyed drum and operates with a reverse-link motion.

(d) The drumless winch consists of two revolving catheads or spools. It is used principally for rapid handling of light loads.

(e) There are many variations and combinations of the winches listed in (a) through (d) above. A two-speed winch, for example, is a variation of the reverse-valve type. The two-speed winch shown in figure 3-9 has two sets of gears that allow the proper gear ratio for light or heavy loads.

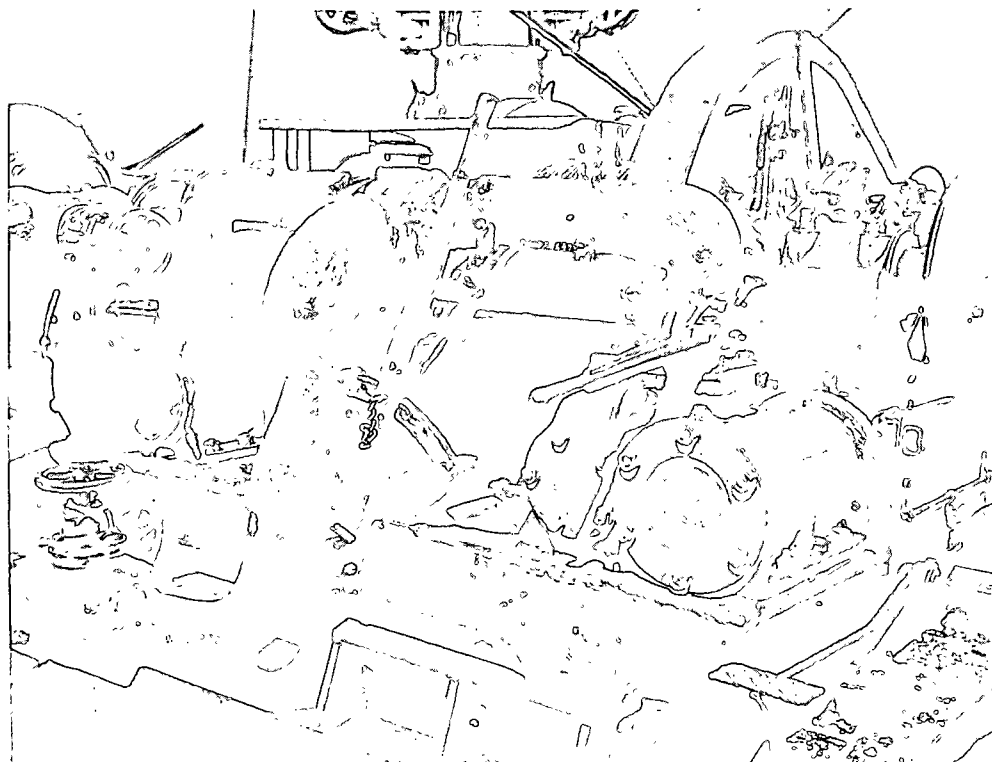


Figure 3-9. Two-speed steam winch, rear view.

(2) Winch operators must carefully inspect the winch before operation:

(a) Important things to look for are—

1. Oily or slick areas which should be cleaned up before operation.

2. Loose or fouled runner on the winch drum. This could cause the winch to reverse itself by allowing the runner to bind or cause the load to jump when the slack is taken up, thus endangering the rigging on heavy loads.

3. Loose lines or material piled up behind the winch that could foul the gears.

4. A loose or defective control handle. The control handle should also be checked in its neutral position to insure that the safety pin functions properly.

5. Excessive slack in the brake. This can be determined by checking the amount of play in the brake pedal when pressure is applied.

6. Runner wound in wrong direction on the winch drum. This will cause the runner to operate opposite the direction indicated on the controls.

(b) The winch operator should also satisfy himself that the rigging is satisfactory and that all running blocks and lines are free. Any condition which could hamper the operation of the winch or endanger the safety of personnel should be corrected before the steam valve to the winch is opened.

(3) The following is the warmup procedure in steam winch operation:

(a) Open the bleeder valves or draincocks. There are generally two under each cylinder and one below the steam chest under the control handle. (The water resulting from condensation as the winch cools after operation must be drained before the winch can be operated again.)

(b) Check to insure that the gear engaging lever is in neutral, and the safety pin is in place.

(c) With the bleeder valves open, open the steam intake and exhaust valves so that steam can circulate freely through the winch.

(d) Run the winch back and forth by alternately raising and lowering the control handle until all the water is driven from the cylinders and steam comes out of the open bleeder valves.

(e) When the cylinders have been cleared of water, put the operating handle in neutral, close the bleeder valves, remove the safety pin from the gear engaging lever and engage the lever into either high or low gear (whichever is required), and reinsert the safety pin. The winch is then ready for use.

b. *Electric winches* now equip most vessels.

(1) Electric winches require no warmup (fig. 3-10). They are quieter than steam winches. The absence of steam pipes on deck results in more usable deck space. Freezing pipes have no effect on electric winches.

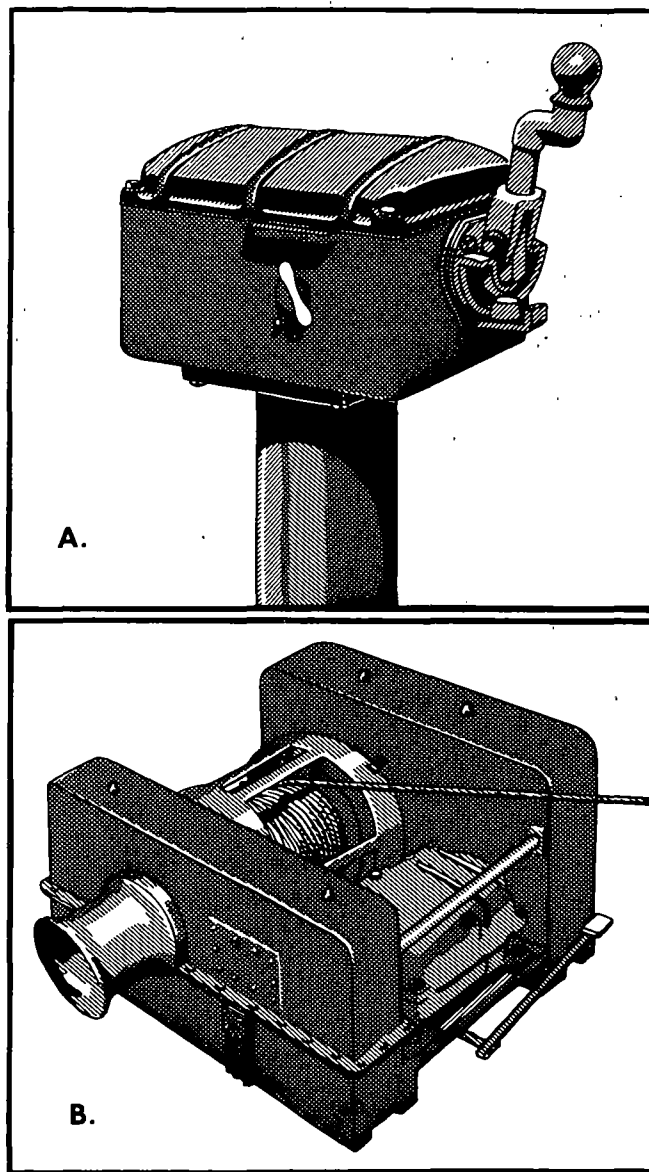


Figure 3-10. Electric winch and winch controls
(A—controller, B—winch).

(2) An electric winch has a steel base on which the winch drum, motor, gears, shafts, and brakes are mounted. The drum is usually smooth with flanged ends and revolves on a horizontal axis. The drum is driven through single or double reduction gears by an electric motor (usually direct current). A solenoid brake and a mechanical brake are fitted to the motor shaft.

The winch may be located on deck or on a deckhouse, and the cargo runner is wound on the drum.

(3) The winch controls consist of a master controller or switchbox located on a pedestal near the end of the hatch square and a group of relays, contactors, switches, and resistors located near the winch motor.

(a) A resistor house may be a small deckhouse between hatches when there is no larger deckhouse near the winch. In unit-type winches, control equipment is located within the housing that is part of the winch. In the unit-type winch illustrated in B, figure 3-10, the control equipment is contained in three compartments opposite the cathead side of the winch. The control panel, the resistor bank, and the solenoid brake are in these compartments.

(b) The control equipment regulates speed in both directions. The master controller illustrated in A, figure 3-10, is normally a five-speed, drum-type, reversing switch commonly found on modern cargo ships. An additional on-off power switch is located on the controller box.

(4) The size of the winch motor depends on the maximum load to be handled on the booms and rigging. Heavier loads normally require changes in rigging and slower speeds. Although boom capacity may range from 5 to 60 tons, a 50-horsepower motor is commonly used on all winches. Since most lifts are 1 to 5 tons, the winches and the rigging are designed to handle these loads at the highest speed practicable. Because the winch motor is a series motor, increasing torque will reduce the speed for heavier loads up to the maximum for the rigging arrangement.

(5) Most winches are equipped with a solenoid brake on the motor shaft. The brake is set by heavy springs and released by energizing the solenoid coil. When the master controller is moved through the various speed positions to the off position, relays are so arranged that dynamic braking occurs for short intervals and then, when the solenoid coil is deenergized, total braking occurs. At least once during every lowering operation, a load going downward at full speed must be retarded and brought to a halt, either when it reaches the deck or when held in the air. Although the speed could be retarded by the friction brake, the frequent wear and tear would require the excessive replacement of brake lining and could necessitate an oversize brake. Dynamic braking on the other hand retards speed without causing wear on the brake lining and requires the magnetic brake only for final slowing or stopping

of the load. For emergency use, a foot-operated brake or other mechanical brake is usually included.

(6) The operation of an electric winch is simple. The speed is determined by the position of the control handle, the amount of runner on the drum, the weight of the load, and the line voltage. In case of an overload, the circuit breaker turns off the electricity, but when the control handle is returned to the off position, power is immediately turned on again.

(7) Running an electric winch at a slow speed over a long period of time causes the resistors to overheat and eventually burn out. By running the winches at a faster rate, the winch operator can avert such breakdowns.

(8) New winch operators should memorize the sequence of steps necessary to prepare electric winches for operation:

(a) Inspect the winch.

(b) Open ventilator covers on control equipment.

(c) Turn the switch on the control box to the on position. (If it is necessary to leave the winch, the switch should be turned to the off position to prevent accidental starting.)

(d) Move the control handle back and forth to insure that the winch is running smoothly.

c. *Hydraulic winches* are being used in increasing numbers to move cargo and equipment. Many foreign ships are equipped with hydraulic winches.

(1) The hydraulic winch has the advantage of smoother operation due to less jerky starts and stops and none of the overheating worries encountered in electric winch operations (b (7) above).

(2) Similar to the electric winch, hydraulic winch control handles are located on pedestals near the square of the hatch. Here they control the direction of rotation and speed of cargo.

(3) The drive equipment of hydraulic winches consists of an electric motor driving a variable displacement pump and a hydraulic motor that, through reduction gears, drives the shaft of the winch.

3-7. Special Purpose Winches

In addition to cargo winches, stevedores may have to use capstans, warping winches, and anchor windlasses aboard a vessel.

a. *Capstans*. Capstans are spool-shaped, vertical revolving drums. They are used primarily to handle large mooring lines. Although some capstans are operated by hand, most are powered by steam or electricity. They are located on the

forecastle deck and on the stern and are used to handle towlines. On large vessels, capstans may also be located amidship.

b. *Warping Winch.* Warping or mooring winches are usually located well aft on the ship. They are used primarily to handle lines aft when the vessel is being moored to a pier. On some vessels, they operate the emergency steering rig. Warping winches provide a good source of power for the guys used in rigging a swinging boom at the afterhatches. The design of warping winches is similar to that of cargo winches. The warping heads (catheads) extend on each side and are

normally larger than those found on cargo winches.

c. *Anchor Windlasses (fig 3-11).* Most anchor windlasses are designed for the dual function of raising and lowering the anchors and handling the forward mooring lines. An anchor windlass is located at the bow of the ship and provides a good source of power for the guys used in rigging a swinging boom at the forward hatches. The main shaft has two specially shaped sheaves or pulleys called wildcats over which the anchor chain rides and two catheads on the ends of the shaft.

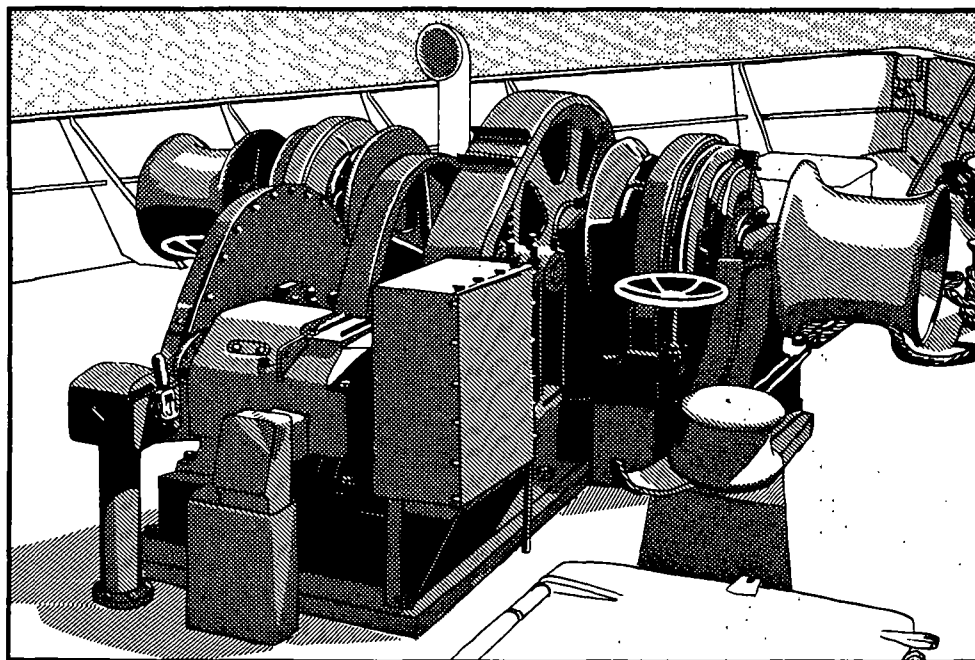


Figure 3-11. Anchor windlass.

(1) The wildcat is a large sheave notched to fit the anchor chain. When the wildcat is locked into the main shaft and the windlass is operated to hoist, the anchor chain is hoisted aboard (heaved in) and deposited in a chain locker directly below the windlass. The windlass may be reversed to let out the chain.

(2) The catheads are secured to the main shaft and revolve with it. When both wildcats are disengaged from the main shaft, the windlass can be used like a warping winch.

3-8. Winch Operation

a. *Cargo Handling Methods.* Present cargo handling methods require two winches for discharging or loading cargo. The winches or

winch controls may be so located that one winch operator can operate both, or the location may be such that two winch operators are required.

b. *Operating Safety Precautions.*

(1) Swinging the draft should be avoided.

(a) Swinging can be prevented in the hold or on the pier by plumbing the draft directly under the head of the boom before hoisting.

(b) Swinging in midair can be controlled by waiting until the draft is at the highest point of its outboard swing and then slacking the cargo runner on the hatch winch quickly so that the draft is directly under the head of the boom (fig 3-12).

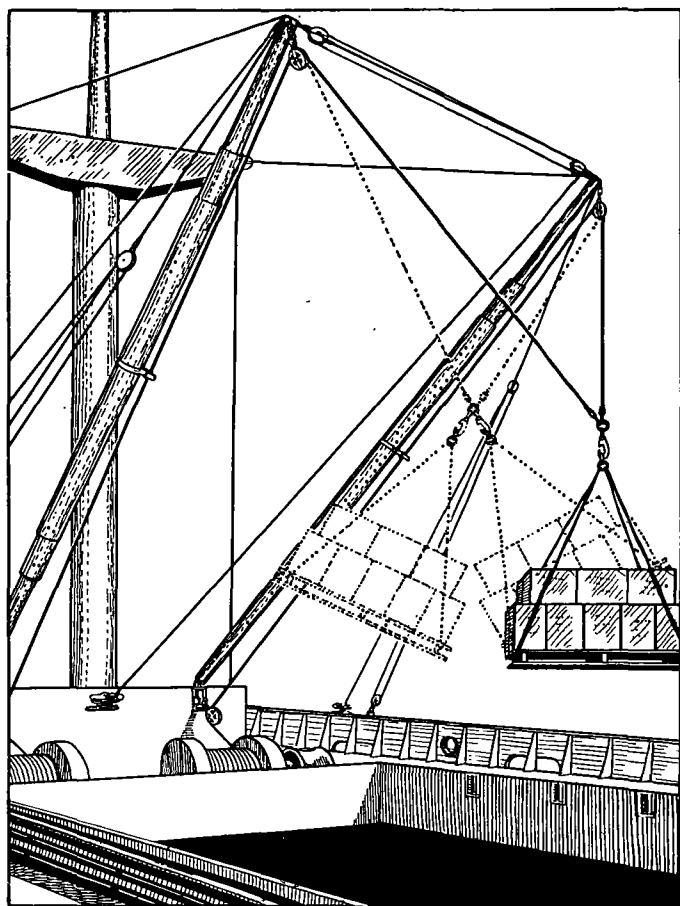


Figure 3-12. Checking the swing of a draft.

(c) Tag lines can be used on long or oversize drafts for additional control.

(2) Rapid starts and stops or sudden stresses should be avoided. Sudden starts or stops may break a cargo runner, part guys or topping lifts, or carry away a block.

(3) The right amount of slack must be kept in a cargo runner which is not under stress.

(a) Insufficient slack will cause the draft to strike against the side of the ship or the hatch coaming.

(b) Too much slack will allow loose turns to pile up on the drum.

(4) An electric winch should always be turned off if it becomes necessary to walk away from the controls. When a steam winch is left unattended, the safety pin should be replaced to keep the

handle from being moved accidentally. The steam valves should also be shut off to prevent the creeping in a winch that has leaky valves or packing.

(5) Slings should be as short as the draft permits. Unnecessarily long slings can permit excessive swinging of a draft resulting in a fiddlestring or tightline pull. This in turn causes excessive strain on the cargo falls and guys as the two winches pull against each other. It also causes a torque or twisting effect on the boom. If the fiddlestring pull is unavoidable because of the type of cargo being handled, a single swinging boom rigging should be considered.

3-9. Signals Used in Winch Operation

a. A winch operator usually cannot see the draft at all times and therefore must depend upon the signalman for instructions. The safety and smoothness of the operation depend upon the judgment of the signalman and the skill of the winch operator to respond; a team effort is essential.

b. Every member of the hatch section must be familiar with the signals used in cargo handling. Each signalman must know the safe methods of slinging cargo and must satisfy himself that the draft is slung properly before giving the winch operator a signal to move it.

c. The signalman must learn to judge the few seconds that elapse between the time the signal is given and the actual stopping of the winch. If allowance is not made for this, accidents may result.

d. The signalman and the winch operator must clearly understand the signals in order to prevent accidents, confusion, and damage to the cargo or the cargo gear.

e. The signalman must place himself in such a position that he can see the draft at all times and that his signals can be clearly seen by the winch operators. Both should continually observe the rigging, paying particular attention to slack guys, chafing runners, loose pins in shackles, strained hooks, and any condition of slings and bridles which could be unsafe.

f. Standard signals for winch operation are illustrated in figure 3-13.

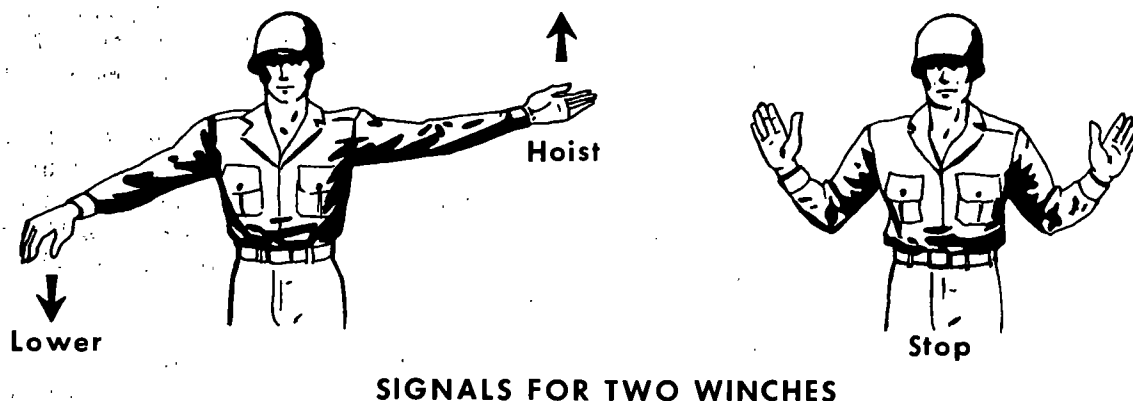
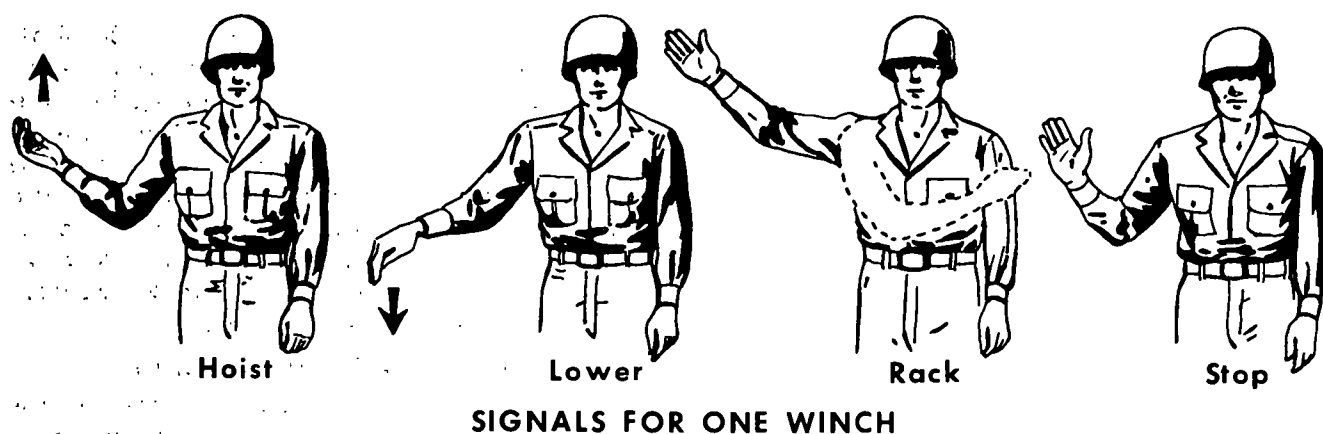


Figure 3-13. Signals used in winch operation.

(1) *Hoist*. The hand is extended palm up, and the fingers are moved upward.

(2) *Lower*. The hand is extended palm down, and the fingers are moved downward.

(3) *Rack*. The arm is extended outward from the body and is crossed over in front of the body in a sweeping motion, pointing the direction in which the draft is to move. This signal indicates that the winch operator should move the load at his discretion and is given only when the draft is in full view of the winch operator.

(4) *Stop*. The arm is extended forward with

the palm facing the winch operator and the fingers extended upward.

(5) *Emergency stop*. This motion indicates a need for immediate action. The arm is extended forward with the palm facing the winch operator and is moved away from the body rapidly and emphatically.

(6) *Signals for two winches*. To signal for two winches, both hands are used. There must be a clear understanding between the winch operator and the signalman concerning which hand controls each winch.

Section III. RIGGING STANDARD CARGO BOOMS

3-10. General

a. Before a ship may be worked, the booms must be raised or topped and properly spotted. Each man in the hatch section should understand the procedure for raising, spotting, and lowering the booms.

b. Booms may be topped and lowered safely by observing the following simple rules:

(1) Hatch foremen must—

(a) Insure that the deck is well policed before rigging begins.

(b) Assign the necessary number of men to specific jobs and have all men stand clear of the deck under the booms.

(c) Require personnel to wear gloves.

(d) Inspect rigging and deck fittings.

(e) Supervise the placement of guy tackles.

(f) Require nonessential personnel to stand clear when booms are being topped or lowered.

(g) Insure that no personnel are standing where they could become entangled in lines about the deck.

(h) Inspect the stopper chain before the weight of the boom is transferred from the cathead.

(2) Winch operators should inspect winches as outlined in paragraph 3-6a (3).

3-11. Topping Booms

a. *Multiple Topping Lifts (Booms in Cradles).* The procedure for topping booms with multiple topping lifts when the booms are in cradles is as follows:

(1) Assign men to winches, guys, runners, topping-lift wire, and cathead.

(2) Prepare winches for operation.

(3) Lay out guys to proper fittings. Proper leads for guys and preventers are discussed in paragraph 3-13.

(4) Lay topping-lift wire along the deck or over the rail. Place hauling part of topping-lift wire in a wire rope snatch block. Take five turns with topping-lift wire around the cathead in the direction opposite to the cargo runner (underneath the cathead). Assign men to clear the topping-lift wire and attend the cathead.

(5) Assign one man to overhaul the runner as the boom is topped.

(6) Assign men to the outboard and inboard guys.

(7) Raise the boom to the desired height by putting the control lever of the winch in position for lowering and take in on the hauling end of the topping-lift wire which is wound around the cathead.

(8) Secure the topping lift by applying the stopper chain carefully as follows:

(a) With the stopper chain secured to a pad eye on deck, pass the running end of the chain around the topping-lift wire, making sure that at the completion of the turn, the running end of the chain passes under the standing end of the chain (1, fig 3-14).

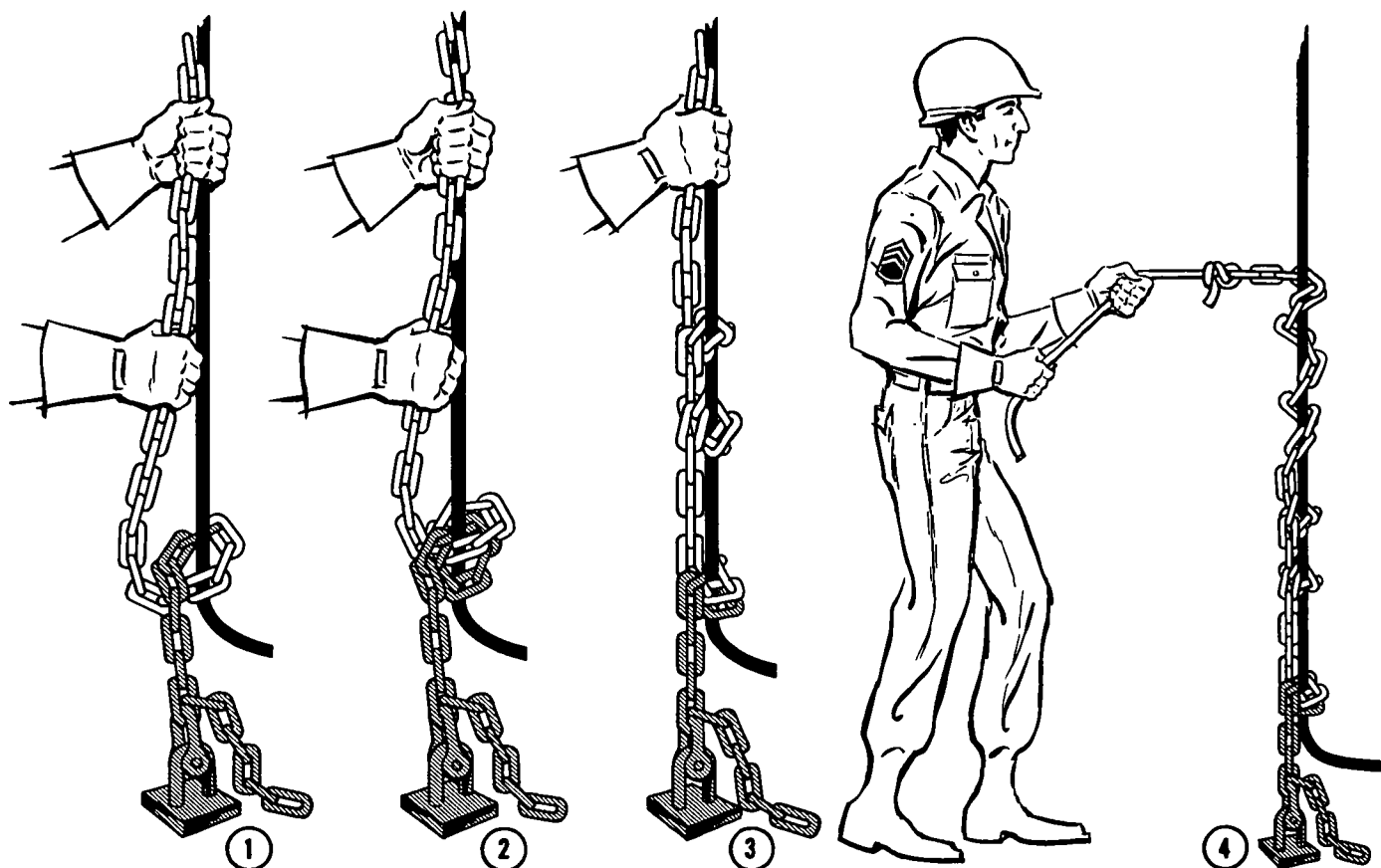


Figure 3-14. Steps in applying stopper chain.

(b) Run the running end of the stopper chain around the topping-lift wire again, making sure that this turn passes over the first turn (2, fig. 3-14). The chain's running end should again go under the standing end at completion of the turn. This completes a double half hitch, rolling hitch, or stopper hitch (3, fig. 3-14).

(c) Holding the stopper hitch tightly in place, take two half hitches above the stopper hitch.

(d) Wind the remainder of the chain around the topping-lift wire so as to bind the half hitches. Have one man hold the chain in this position (4, fig. 3-14).

(e) With the turns still on the cathead, slack off the topping-lift wire slowly until the weight of the topping lift is transferred from the cathead to the stopper chain.

(f) When the chain has the weight of the topping lift, remove the turns from the cathead and secure the topping-lift wire to the topping-lift cleat by taking three round turns on the cleat followed by three figure eights.

(g) Tie or mouse the figure eights with a piece of rope yard or wire. The remainder of the topping-lift wire can be coiled loosely around the cleat to keep it off the deck and out of the way.

(h) Remove the stopper chain.

(9) Swing booms to working position by hauling on the guys and spot according to type of rigging desired.

(10) Equalize guys and preventers.

b. Single Topping Lift (Booms in Cradles). The procedure for topping booms with a single topping lift when the booms are in cradles is identical to that for multiple topping lifts with two exceptions:

(1) On vessels rigged with single topping lifts, the catheads are equipped with a fitting to which the bull rope can be made fast. When this fitting is available, the bull rope is secured to it instead of five turns being taken around the cathead as described in *a* (4) above.

(2) The stopper chain is not used; instead, the topping lift is secured as follows:

(a) After the boom has been raised to the desired height, shackle the bull chain to the deck as shown in figure 3-15.

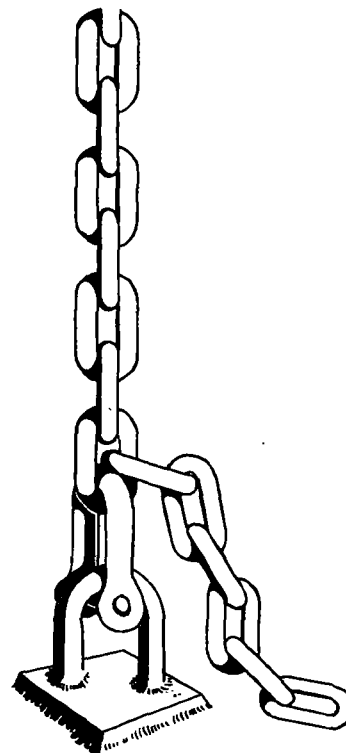


Figure 3-15. Bull chain secured.

(b) Slack off the bull line slowly until the chain supports the weight of the boom.

(c) Remove the bull line from the cathead and coil it around the cleat. It is only necessary to get the bull line off the deck and out of the way since it does not support the topping lift unless the boom is being topped or lowered.

c. Topping-Lift Winches. Most of the newer cargo ships are equipped with separate topping-lift winches. Booms can be topped or lowered simply by operating the topping-lift winch.

3-12. Lowering Booms

a. Multiple Topping Lifts.

(1) The procedure for lowering booms is as follows:

(a) Assign men to winches, guys, runners, topping lift, wire, cathead, and stopper chain.

(b) Apply the stopper chain as explained in paragraph 3-11a (8).

(c) Remove all the topping-lift wire from the topping-lift cleat, except the three round turns, and carefully "slack off on" (surge) the topping-lift wire until the stopper chain supports the weight of the boom.

(d) Transfer the wire from the cleat to the cathead, taking the five turns in the same direction as the cargo runner (over the cathead).

(e) Take up on the winch until the strain is transferred from the stopper chain to the cathead.

(f) Remove the stopper chain.

(g) Lower the boom using the winch.

(2) While the booms are being lowered, men assigned to tend guys take in on the guy tackles and those assigned to tend the runner overhaul it to prevent turns from piling up on the winch.

(3) Booms may be lowered into cradles and secured upon completion of the operation, or they may be secured in any other manner the ship's master may desire.

(4) When booms are down, all gear is secured as follows:

(a) Rewind runners smoothly on the drum of the winch and secure the cargo hook to a ring or a pad eye with a slight strain.

(b) Secure guys to the heel block or fittings on the mast table and pull taut.

(c) Coil the hauling parts of outboard and inboard guys over the guy tackles and tie off the guys. Make amidship guys fast to the cleat on the mast.

(d) Secure topping-lift wires to the topping-lift cleat.

b. Single Topping Lift. The procedure for lowering booms with a single topping lift is identical to that for multiple topping lifts except for the procedures listed below:

(1) The weight of the boom is transferred to the cathead as follows:

(a) Remove the bull line from the cleat and secure it to the fitting on the cathead, if available, making sure that the bull line is led through a snatch block to the cathead and not directly to the cathead. If there is no such fitting, take five turns around the cathead in the same direction as the cargo runner (over the cathead).

(b) Raise the boom slightly to remove the weight from the bull chain and remove the shackle which secured the bull chain to the deck.

(c) The boom may now be lowered by depressing the control handle of the winch.

(2) After the booms are down, the gear is secured as in a (4) (a) through (d) above. The

bull chains are then shackled to pad eyes, and bull ropes are hung over the topping-lift cleat.

3-13. Guying Booms

a. Methods of Guying.

(1) There are two methods of guying the fixed booms of the yard-and-stay type of rigging:

(a) Outboard and inboard guys.

(b) Outboard and amidship guys.

(2) Both methods are used aboard cargo ships, although the outboard and amidship method is more common. If the inboard guy is used, it is necessary to find a place on the deck or bulwark to secure it. This puts additional gear in a location already overcrowded. Since the load on the cargo hook is always between the heads of the booms or directly under one of them, there is always less stress on the inboard or amidship guys than on the outboards guys. The light-weight amidship guy is sufficient to carry the stress and is raised aloft out of the way.

b. Equalizing Guys and Preventers. In addition to the regular outboard guy on the fixed boom, an additional wire is attached to the head of the boom and led to the deck to act as a preventer. The preventer, which provides additional support to guys, is usually made of 5/8- or 3/4-inch wire rope. Great care must be taken in the use of these preventers.

(1) An unsafe practice to be avoided is that of rigging the preventer so that the guy takes all the stress and the preventer takes stress only if the guy parts.

(2) A preventer should not be expected to share all loads equally with the guy. This is because the preventer is usually a single heavy wire while the guy has a manila or synthetic fiber purchase. This leads to a situation where, if the guy and preventer have equal tension under a light load, the guy stretches much more than the preventer under heavy loads so that the preventer has to take most of the increase. This can be avoided by adjusting the guy under a light load so that there will be a little more tension on it than on the preventer. Under a heavy load, then, the guy will stretch and let the preventer have its share.

(3) The safest practice is to secure the guy and preventer as close together as possible without securing them to the same fitting. This is because if the guy is in one place and the preventer in another, the desired equalization of tension between the two will not be achieved, since under different degrees of tension the stress on one will increase more rapidly than on the

other. Once the guys and preventers have been secured as close together as possible, the procedure for equalizing guys and preventers is as follows:

(a) Swing booms slightly beyond the spotting position (approximately 2 to 4 feet).

(b) Make guys and preventers fast.

(c) Place a strain on the outboard guys and preventers by lifting a light draft equally between the two booms.

(d) Take in all the slack in the inboard or amidship guys. The booms will swing inboard to the desired position. This should nearly equalize the strain between the outboard guys and preventers, depending on how close together the guys and preventers are secured. As mentioned in b (2) above, with this light draft there should be slightly more strain on the outboard guys than the preventers, in order that when a heavy draft is lifted, the differently constructed guys will stretch slightly, thus equalizing the strain between guys and preventers. However, if the guys and preventers are constructed of the same materials, they react to heavy and light loads equally and not as described in (2) above. Therefore when the guys and preventers are of identical material, the outboard guys should be slacked off slightly to equalize the strain, even with a light load, after the booms have swung inboard and nearly equalized the strain between the outboard guys and preventers.

(4) When the guy and preventer cannot be nearly parallel, it is preferable that the guy be in the position of greater stress; i.e., more nearly in line with the fall under most conditions.

(5) Neither the preventer nor the guy should have any slack in it, as it is almost a certainty

that if one fails, the other will part when it fetches up with a jerk after the slack is taken out, and there will be two pieces of gear flying around instead of only one. In addition, if unnecessary slack is allowed to develop in guys, booms may slap about.

(6) While there have been a few instances in which either the guy or preventer parted and the other held, it is undoubtedly true that the proper use of preventers has saved many a weak guy. Preventers, therefore, should be considered useful only in keeping the guy from parting, not in holding the boom after the guy parts. A few vessels have heavy preventers (which are intended to carry the guy load) and very light guys (which are intended only for trimming the booms). Since little additional strength is provided by such guys, they should not be left slack.

(7) Since the manila guy purchase shrinks when wet and stretches when dry, it must be checked from time to time during a job. Synthetic fiber lines are not affected by moisture.

c. Positioning Guys.

(1) *Positions of guy and boom.* The importance of properly guying booms with respect to the angles of stress cannot be overemphasized, particularly when using married falls. Should guys be carried away because of overstress, loss of time, cargo, cargo gear, and even loss of lift could result. Figure 3-16 illustrates three positions of the guy and boom, and table 3-1 shows how strains vary with these positions. In figure 3-16, A denotes that the guy is in line with the fall, B that the guy is at a right angle to the boom, and C that the guy is behind the heel as far as it is possible to place it without topping.

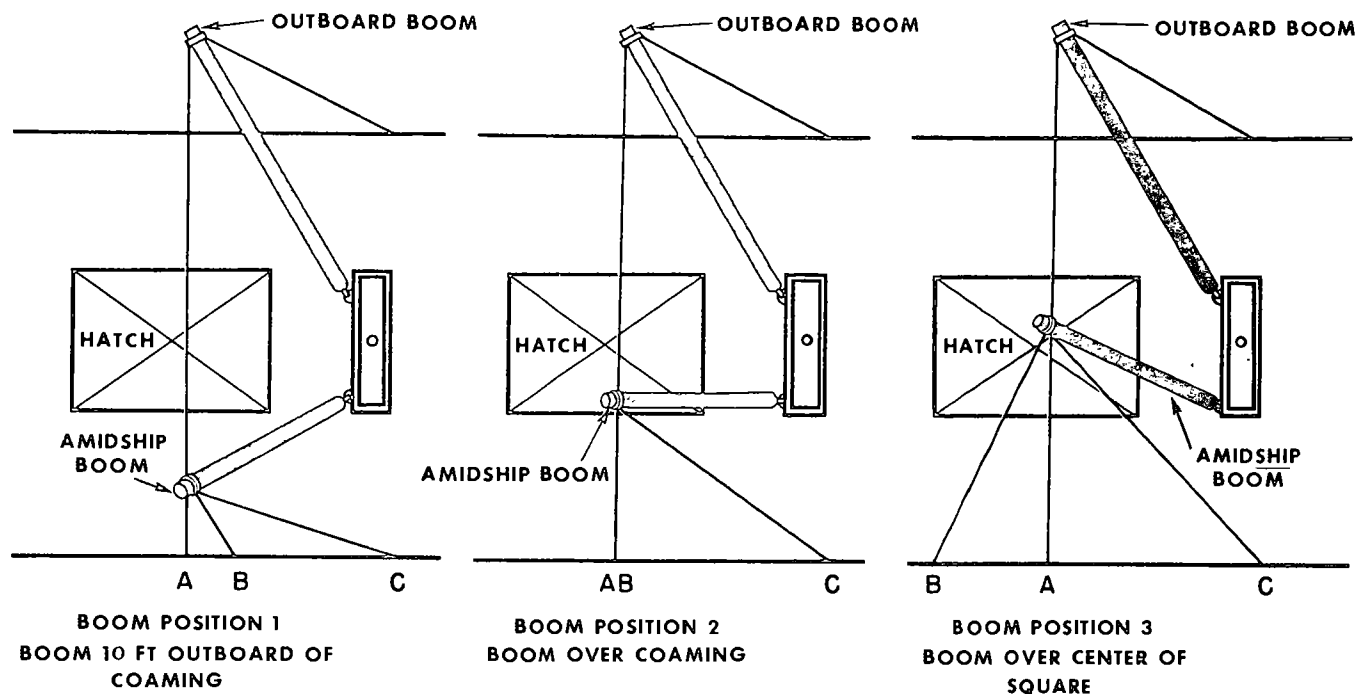


Figure 3-16. Strains with various positions of guy and boom.

Table 3-1. Strains on Cargo Gear at Various Guy Positions
(Load, 1 STon; falls, 30 degrees from horizontal)

Boom position	Guy position	Guy strain (tons)	Amidship-boom strain (tons)	Topping-lift strain (tons)
1	A	4.3	7.0	2.4
1	B	3.2	5.4	1.3
1	C	2.4	4.0	.3
2	A	2.6	4.7	1.4
2	B	2.6	4.7	1.4
2	C	2.6	4.1	.2
3	A	2.3	4.2	1.4
3	B	1.3	3.2	1.5
3	C	3.1	4.4	.2

(a) The greatest drift and the lowest possible strain result when the amidship boom is angled far inboard and the guy is placed at a right angle to the boom (boom position 3, guy B, fig 3-16).

(b) With the amidship boom head over the coaming (boom position 2) or outboard of it (boom position 1), the guy should be led as far back of the heel as possible without topping (boom position 2, guy C, and boom position 1, guy C).

(c) The greatest strain results when the amidship boom angles outboard and the guy is in line with the fall (boom position 1, guy A).

(2) *Position of load.* Figures 3-17(1) through (4) show the after end of No. 4 hatch on a C3 cargo vessel. The gear has been trimmed to work the near end of the hatch with the up-and-down boom in a fore and aft line through its heel and the guy in line with the fall. The figures and paragraphs following deal mainly with the swinging boom and outboard guys and only briefly with the inboard gear, since experience shows that the first two are where failures in capacity usually occur.

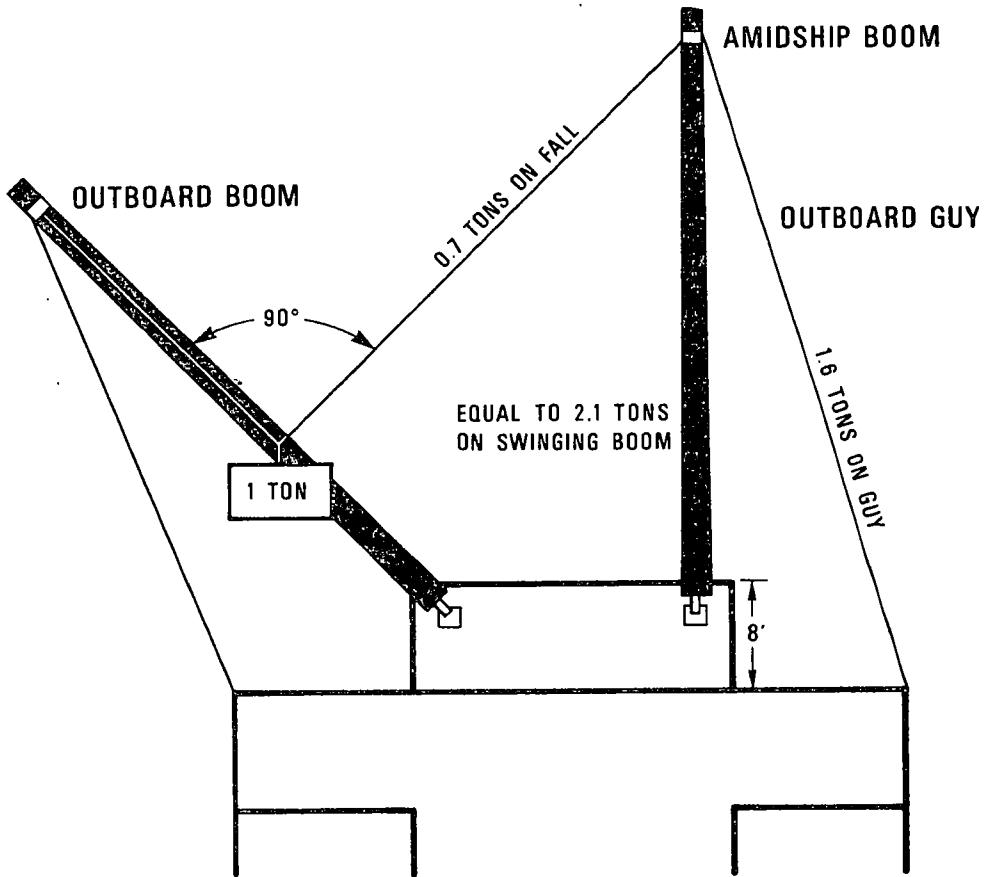


Figure 3-17(1). Load suspended at 90° fall angle.

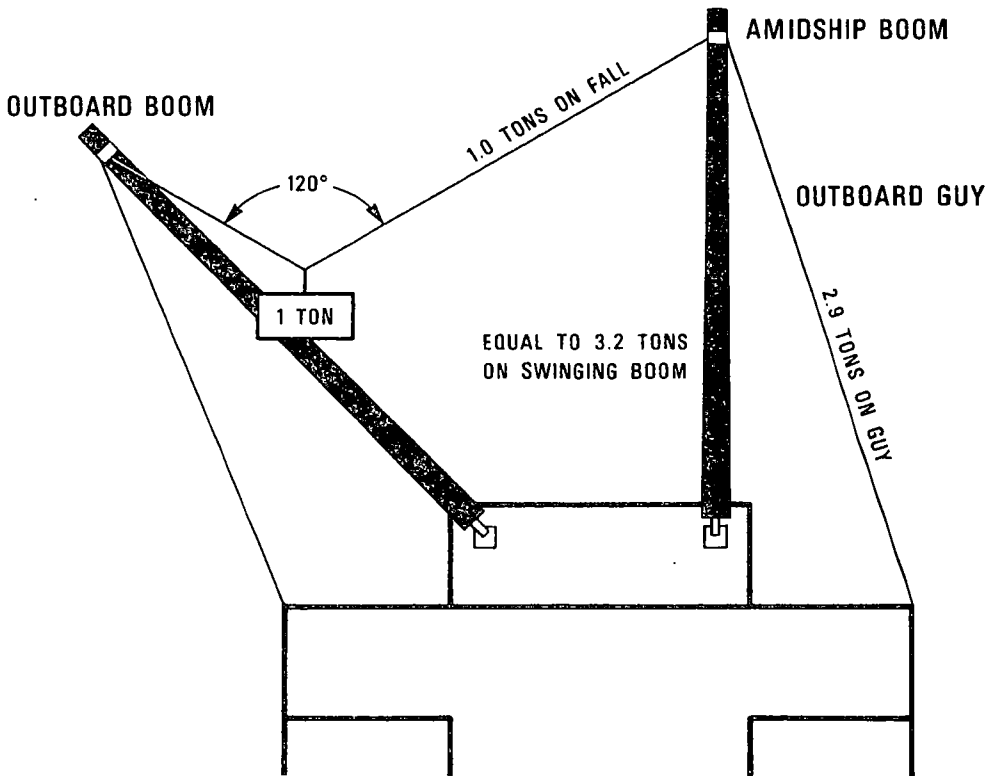


Figure 3-17(2). Load suspended at 120° fall angle.

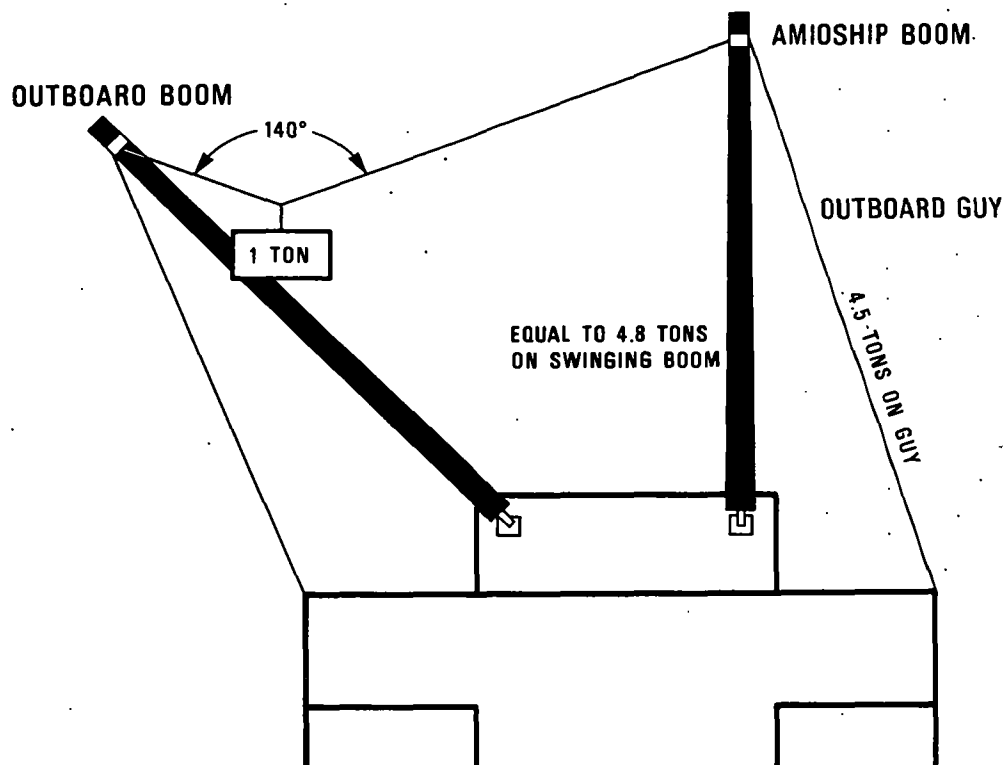


Figure 3-17(3). Load suspended at 140° full angle.

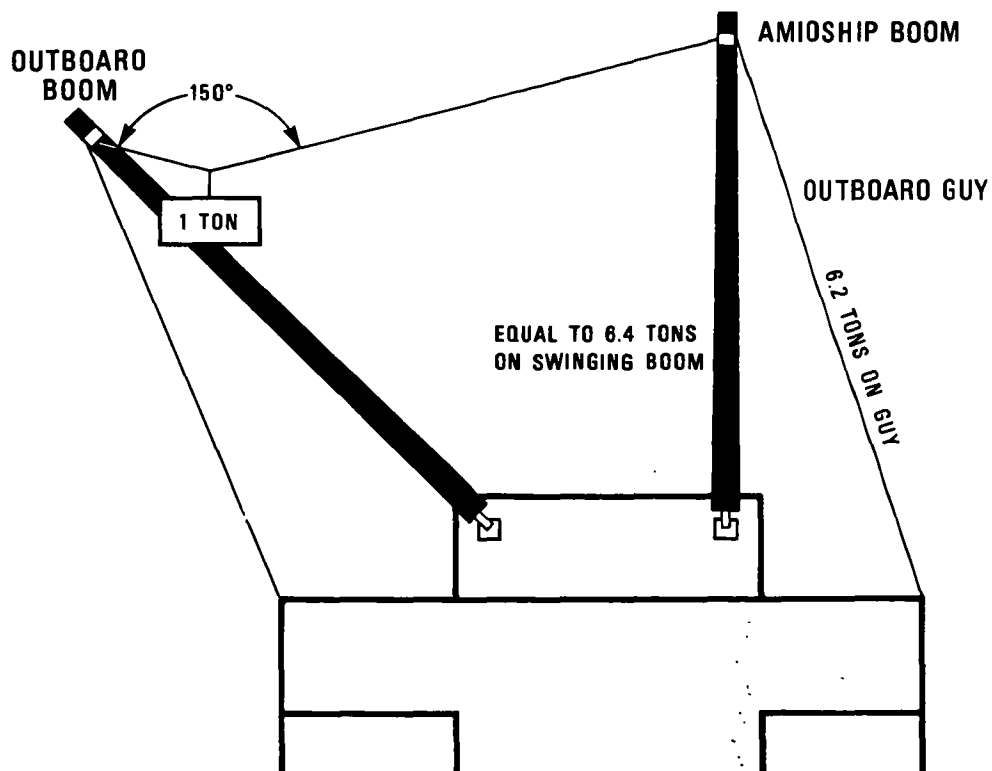


Figure 3-17(4). Load suspended at 150° full angle.

(a) Figures 3-17(1) through (4) also show a 1-ton load suspended at various load positions

using two booms and married falls. Next to the amidship boom in each figure is given the weight

of load which when lifted on a single swinging boom, would produce approximately the same strain (compression) as the 1-ton load does in that figure.

(b) Note that even with a fall angle of only 90°, where the junction of the falls is about 20 feet above the deck (fig 3-17(1)), the tension on the outboard guy of the stay boom is 1.6 tons, and the swinging boom has to support the equivalent of 2.1 tons. The stresses go up (figs 3-17(2) and 3-17(3)) as the 1-ton load is raised until the angle between the falls reaches 150° (fig 3-17(4)), when the tension on the outboard guy of the stay boom is 6.2 tons and the equivalent load on the swinging boom is 6.4 tons.

(c) This explains why a boom which has been tested with a swinging load of 7 tons will sometimes fail under a load of only 3 or 4 tons which is being supported by two booms. Unless otherwise stated, "5-ton SWL" stenciled on the heel of a boom refers to a load on a swinging boom, not one being lifted by using married falls.

(d) Note also how the strain on the falls in figure 3-17(1) through (4) varies with the angle between them produced by each load position. Figure 3-18 shows this principle in more detail. As the angle between the falls increases, the strain on each fall increases according to the percentages shown. Once the angle between them increases beyond 120°, just a small change in the angle causes a massive increase in the strain exerted on each fall. For example, D, in figure 3-18, only a 20° increase in angle (from 120° to 140°) causes a 41 percent increase in the strain exerted on each fall. In F, figure 3-18, a 10° increase in angle (from 150° to 160°) causes a 94 percent increase in the strain exerted on each fall. Finally, in H, figure 3-18, a 5° increase in angle (from 170° to 175°) causes a 576 percent increase in the amount of strain exerted on each fall, and a load held with a 175° angle between falls exerts a strain equivalent to 1,146 percent or 11½ times the weight of the original load on each fall.

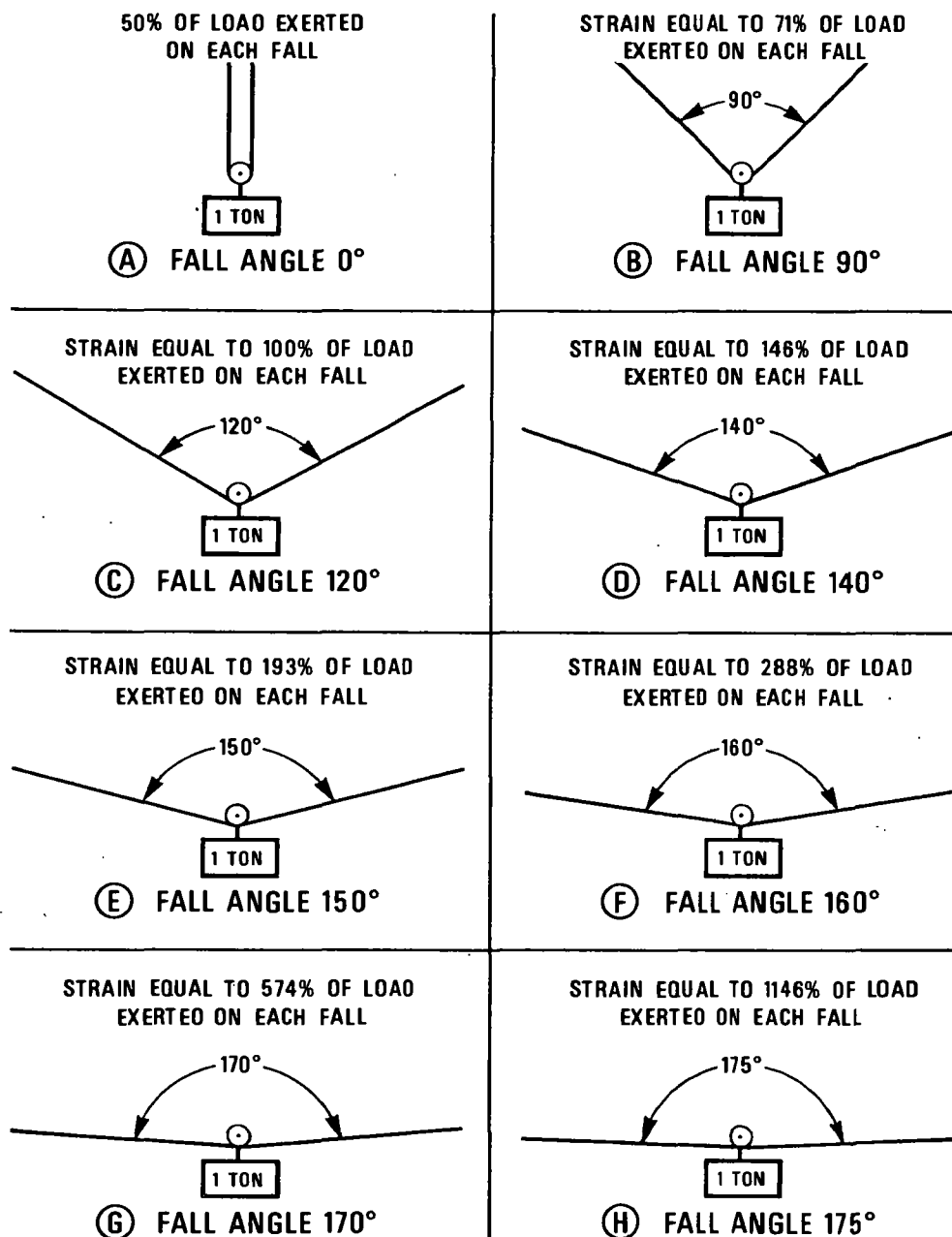


Figure 3-18. Strains vary with angle of falls.

1. The terminal operations specialist can utilize the figures given here by multiplying the weight of a particular load by the percentage given, with the approximate angle at which his load is suspended.

2. The additional pull being exerted on the falls as the angle increases is mainly a horizontal pull; i.e., one which tends to move the two supporting booms toward each other. Table 3-2 lists the tension on each fall at various fall angles, both as a percentage of the weight of the load (column b) and in pounds (column c), and

how much of that tension is a horizontal pull tending to bring the boom heads together (column d). With a heavy load, the final angle of the falls will be smaller than in the case of a light load, since the winch can more easily "tightline" a light load (H, fig 3-18), than a heavy load. Tightlining occurs when the angle between the falls approaches 180°. A lighter load suspended at a higher height will produce a greater horizontal pull than the heavier load which stalls a winch at a lower height.

Table 3-2. Effect of Fall Angles on Fall Tensions

(a) Fall angle (degrees)	(b) Percentage of strain on each fall to weight of load (percent)	(c) Tension on each fall with load of 1 STON (pounds)	(d) Horizontal pull tending to bring boom heads together (pounds)
0	50	1,000	0
60	57	1,155	577
90	71	1,414	1,000
120	100	2,000	1,732
140	146	2,924	2,748
150	193	3,864	3,732
160	288	5,759	5,671
170	574	11,474	11,430
175	1,146	22,926	22,904

3. Table 3-2 and figures 3-16, 3-17, and 3-18 illustrate that severe tightlining of even very light loads between two booms is dangerous because a difference of only a foot or two in the height of the load (increase in the fall angle) may increase strain tremendously. The following techniques should be employed to minimize the degree of angle between married falls:

(a) Use slings which are no longer than necessary.

(b) Keep the hook as close to the junction of the falls as possible. If chain is used for additional weight, hang it in a bight beside the hook rather than between the hook and the junction of the falls.

(c) Keep loads as low as possible, but maintain sufficient height for them to clear the ship's rail.

(3) *Topping or jackknifing of booms.* Topping occurs when strain is placed upon a boom resulting from incorrectly positioned guys. A topping or jackknifing boom can cause considerable damage to the ship's gear and result in loss of life. It is, therefore, important to determine whether or not the guys are properly placed to prevent topping of a boom. This can be accomplished by the following visual tests:

(a) To determine if the outboard boom can top—

1. Sight from the pad eye (A, fig 3-19) where the lower end of the outboard boom's outboard guy is secured, to the head of the amidship boom (B, fig 3-19); if the line of sight passes behind the heel of the outboard boom (C, fig 3-19), the boom can top.

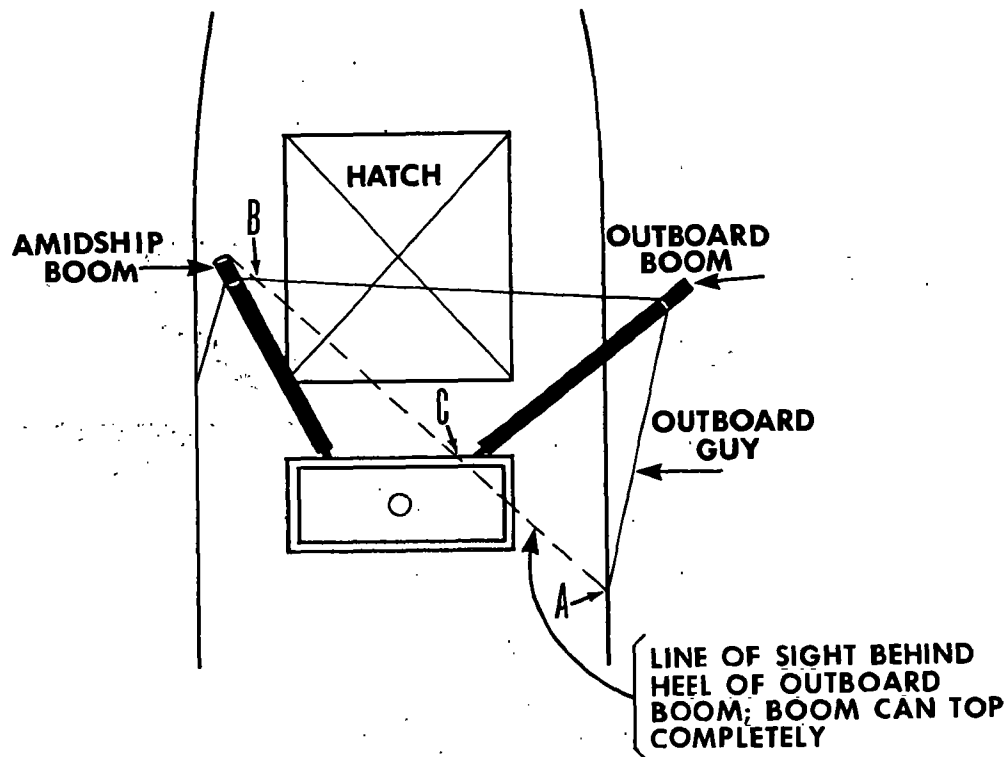


Figure 3-19. Determining if outboard boom can top completely.

2. If the line of sight is ahead of the heel and below the outboard boom, it will not top (fig 3-20). If the line of sight is ahead of the heel but

above the boom, it will top but only until it reaches the line of sight.

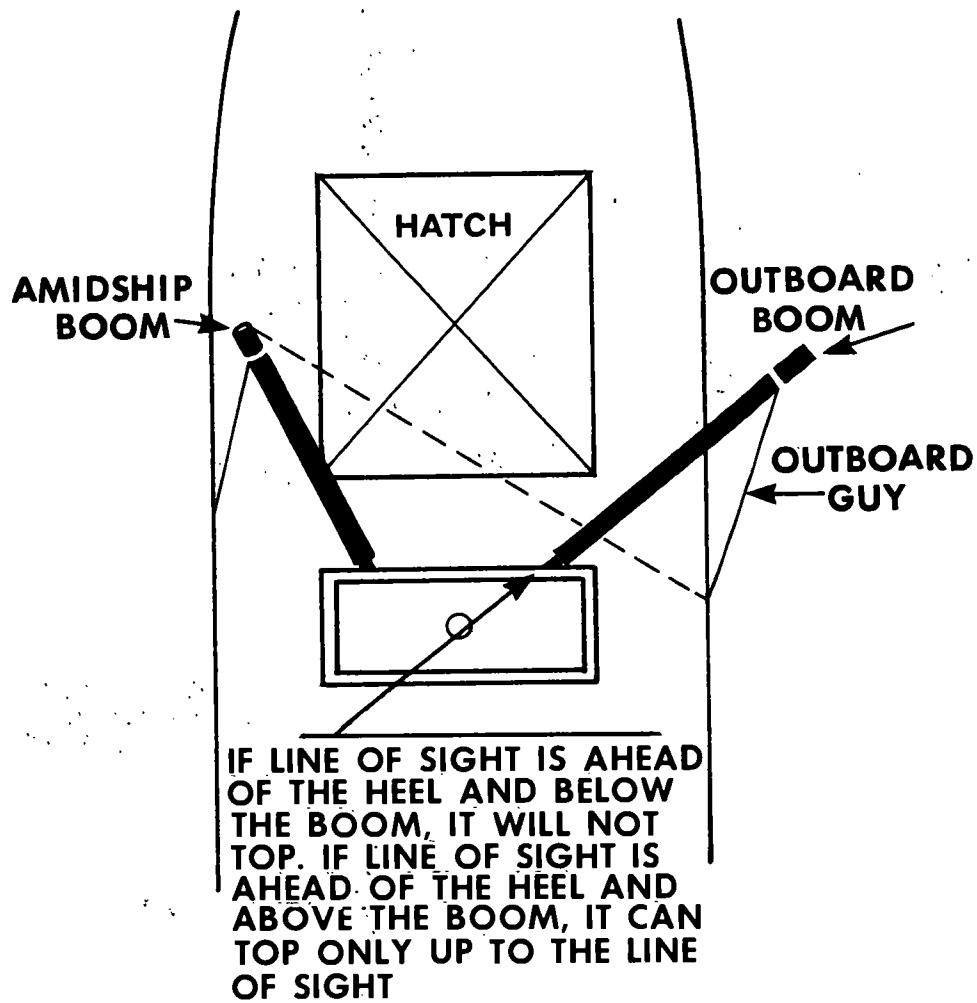


Figure 3-20. Determining if outboard boom cannot top completely.

(b) To determine if the amidship boom can top—

1. Stand at a point near the ship's rail where the distance from the heel of the amidship

boom to the head of the outboard boom can be sighted. If the outboard guy of the amidship boom passes above the line of sight, the boom will top (fig 3-21).

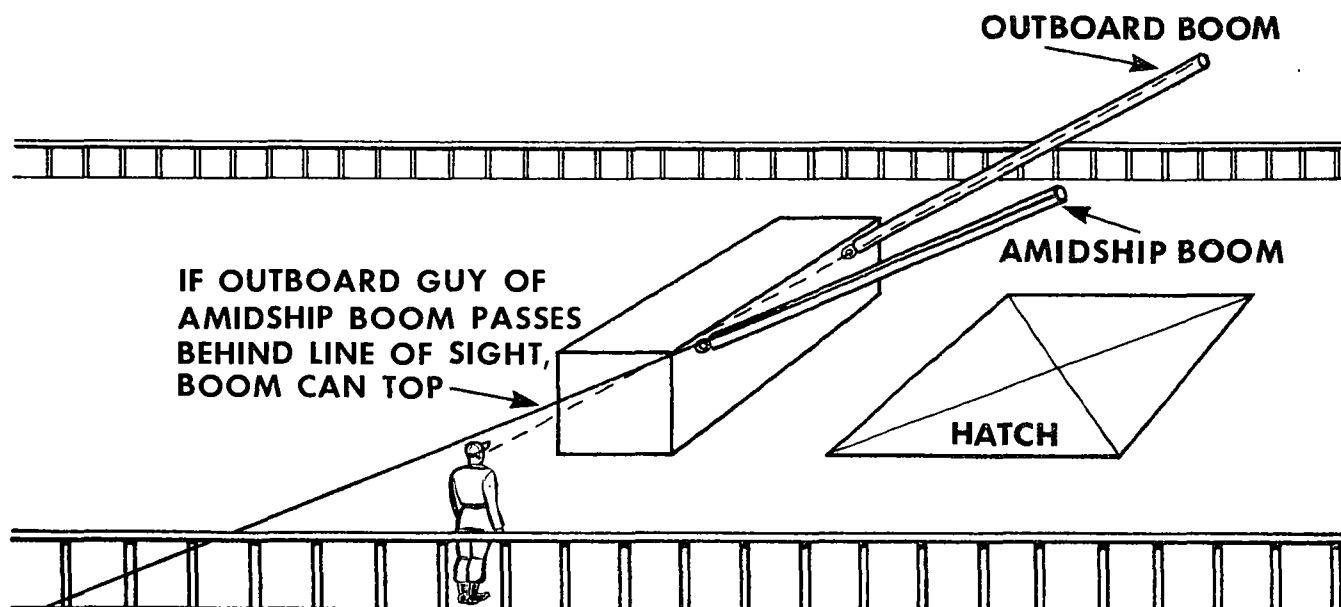


Figure 3-21. Determining if amidship (stay) boom can top.

2. If the outboard guy of the amidship boom passes below the line of sight, the boom will not top (fig 3-22).

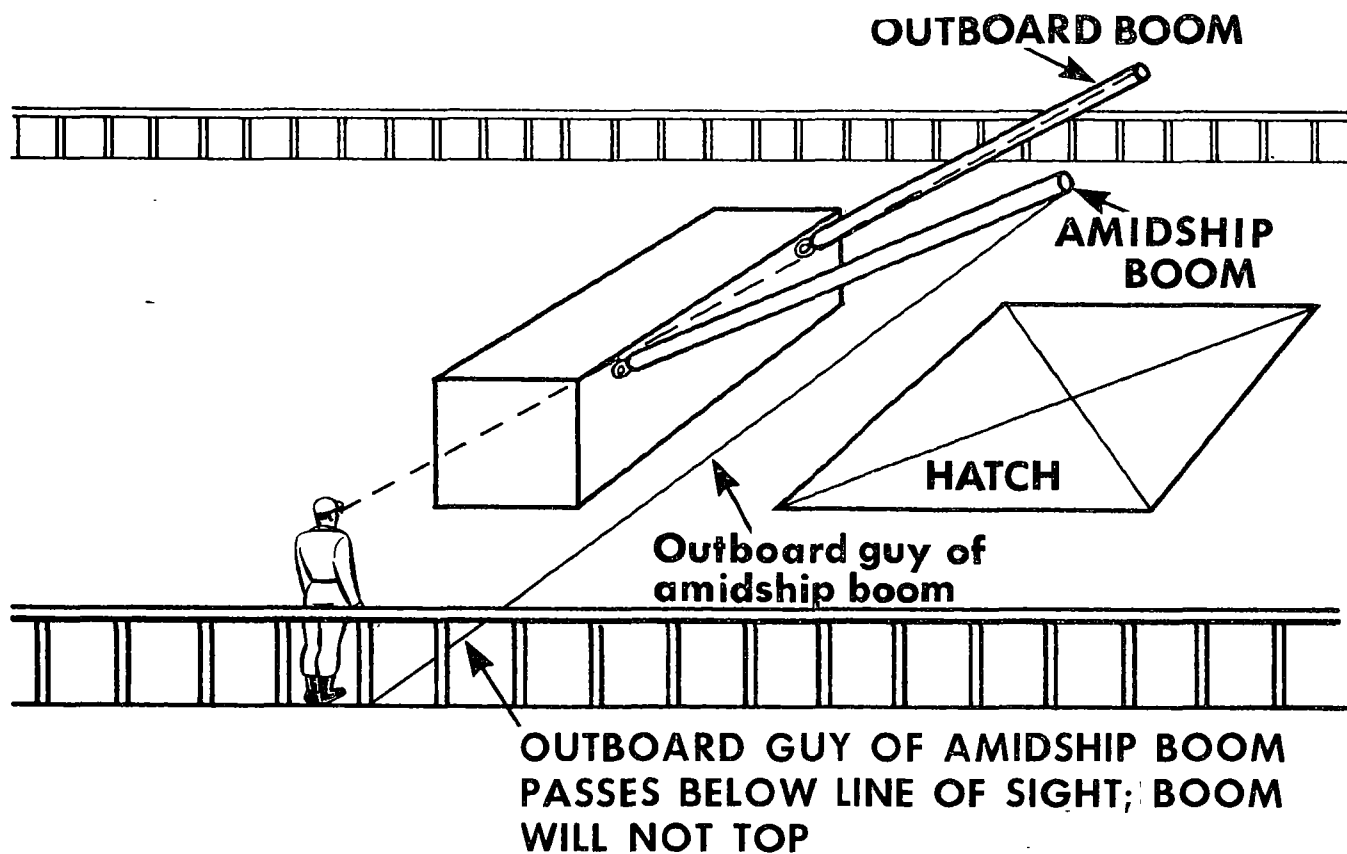


Figure 3-22. Determining if amidship (stay) boom cannot top.

3. There is one exception to the rules in (a) 2 above. When the heels of the booms are far outboard from the centerline, placing the guy in the manner just described to prevent the outboard boom from topping all the way will result in the guy being nearly parallel to the boom. This puts the guy under terrific tension and may result in the failure of either the guy or the boom. In this

case the guy should be left well back of the heel of the boom where the stresses are minimal, and the preventer should be placed well ahead of the heel, with a foot or so of slack. This slack is an exception to the general rule for preventers (b) (5), above. When the boom tops up, as it will try to do, the preventer will limit the amount of rise.

Section IV. SINGLE-RIGGED CARGO BOOMS

3-14. Yard-and-Stay Rig (fig 3-23)

a. One rig used on merchant ships for loading and discharging cargo, particularly when there is a new winch operator or heavy drafts are in-

volved, is the yard-and-stay system. This rig is sometimes referred to as the union, married falls, or Burton system.

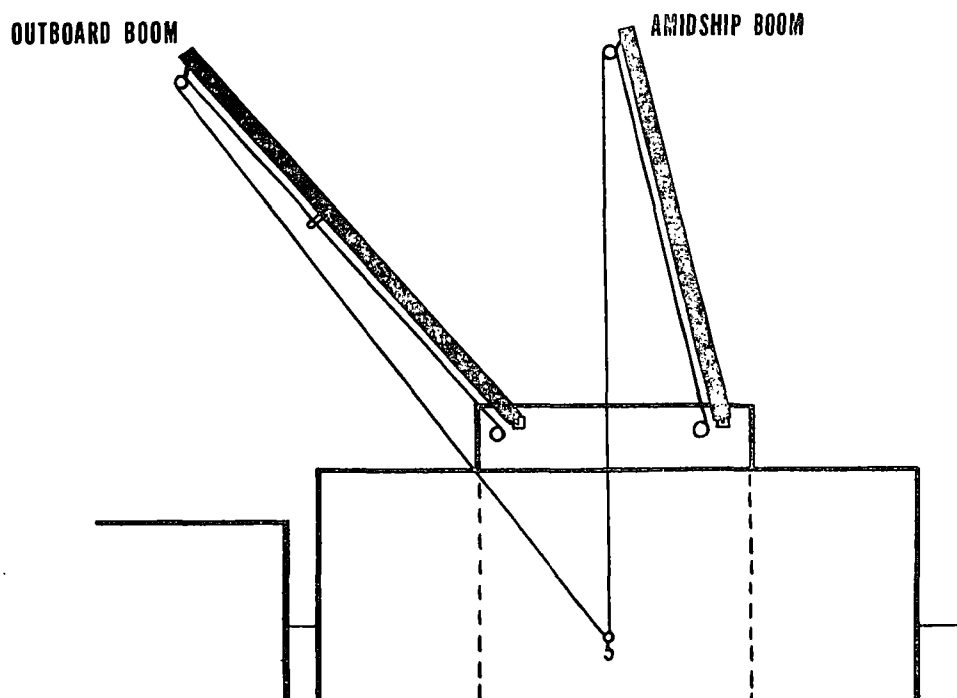


Figure 3-23. Spotting booms with yard-and-stay rig.

b. For the yard-and-stay method of rigging, one boom is spotted over the center of the hatch (referred to as the admidship boom, the stay boom, or the hatchboom) and the other boom is spotted over the side of the vessel (referred to as the outboard boom, the yardboom, or the Burton boom). The ends of the cargo runners are shackled or married to a single cargo hook.

c. In discharge operations, the cargo is attached to the cargo hook in the center of the hatch. The draft is lifted directly up by the cargo fall of the boom spotted over the hatch. At the same time, the slack in the other fall is taken up. As the draft reaches the desired height above the

coaming, the lifting cargo fall is stopped and then slacked off while the fall on the outboard winch continues the lifting operation. This action carries the draft of cargo over the side of the vessel. The outboard winch then lowers the draft to the pier.

d. In loading cargo, the operation is reversed.

3-15. West-Coast Rig (Fig 3-24)

The West-Coast method of rigging is a modified form of the yard-and-stay method and is the most common rig used by the military. This operation differs from the yard-and-stay method only in the way the amidship boom is spotted and the slightly different method of operating the win-

ches. The amidship boom is spotted approximately half way between the hatch coaming and the ship's side. The particular advantages of the westcoast rig are the speed and ease with which the draft can be landed on either side of the hold or 'tween deck close to the point of stowage.

Skillful winch operation is required because the draft is raised from the hold or lowered into the hold, supported equally by both runners. Normally, this type of operation requires only one winch operator, but the winch controls may be so located that two operators are necessary.

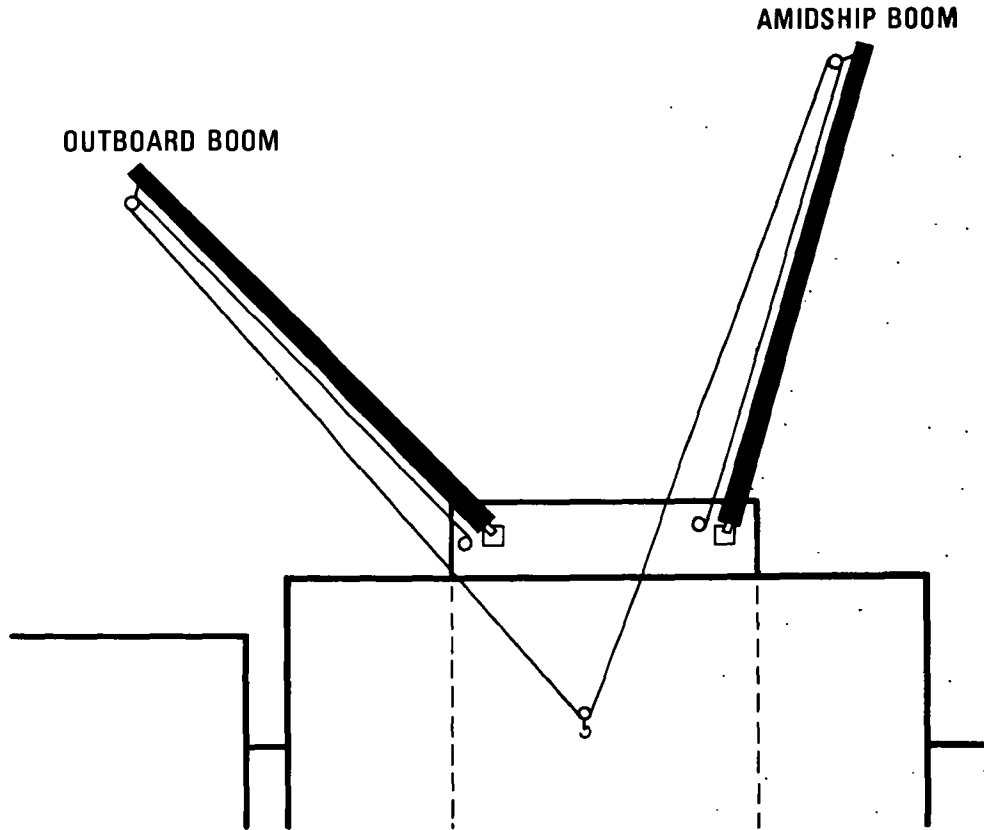


Figure 3-24. Spotting booms with a west-coast rig.

3-16. Wing-and-Wing Rig (fig 3-25)

a. Another modification of the yard-and-stay method of rigging is the wing-and-wing method which differs from the yard-and-stay method in the way the booms are spotted and the winches

are operated. Both booms are spotted over the side of the ship, one boom on each side. The load is lifted from the hatch supported equally by both runners. Skillful winch operation is necessary to avoid tightlining.

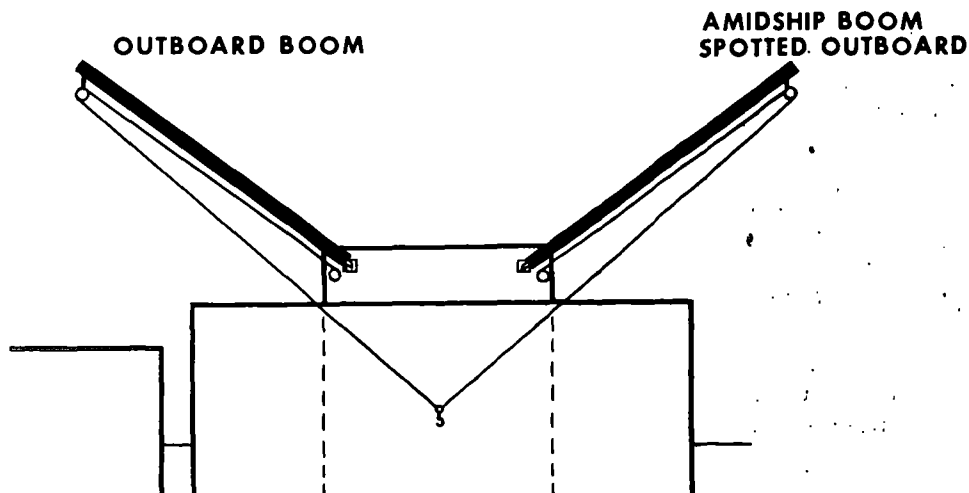


Figure 3-25. Spotting booms with a wing-and-wing rig.

b. The wing-and-wing method is especially useful when it is necessary to handle loads on both sides of the ship while loading or discharging. It is used mainly in logistics over-the-shore (LOTS) operations.

c. This rig can be used to work cargo in the hatch, but, unless the coaming is equipped with rollers, the cargo runners will chafe against the coaming, wearing out the wire and butting grooves into the coaming.

3-17. House Falls (fig 3-26)

a. A house fall is a cargo block made secure on a steel structure on the face of the pier shed in such a way that a cargo fall reeved through it plumbs the pier apron. The structure may be a

steel outrigger or a short boom stepped on the side of the building. To rig the house fall, the runner on the outboard boom is taken off the winch and replaced with a longer runner. The new runner is reeved through the heelblock of the outboard boom and the cargo block on the pier and married to the fall on the amidship boom. The amidship boom is spotted as it would be for conventional yard-and-stay rigging. Some piers are equipped with pier winches. If these are available, the house fall is placed on the pier winch, reeved through the cargo block on the pier, and married to the cargo runner of the hatch boom. This method requires a winchman on the pier.

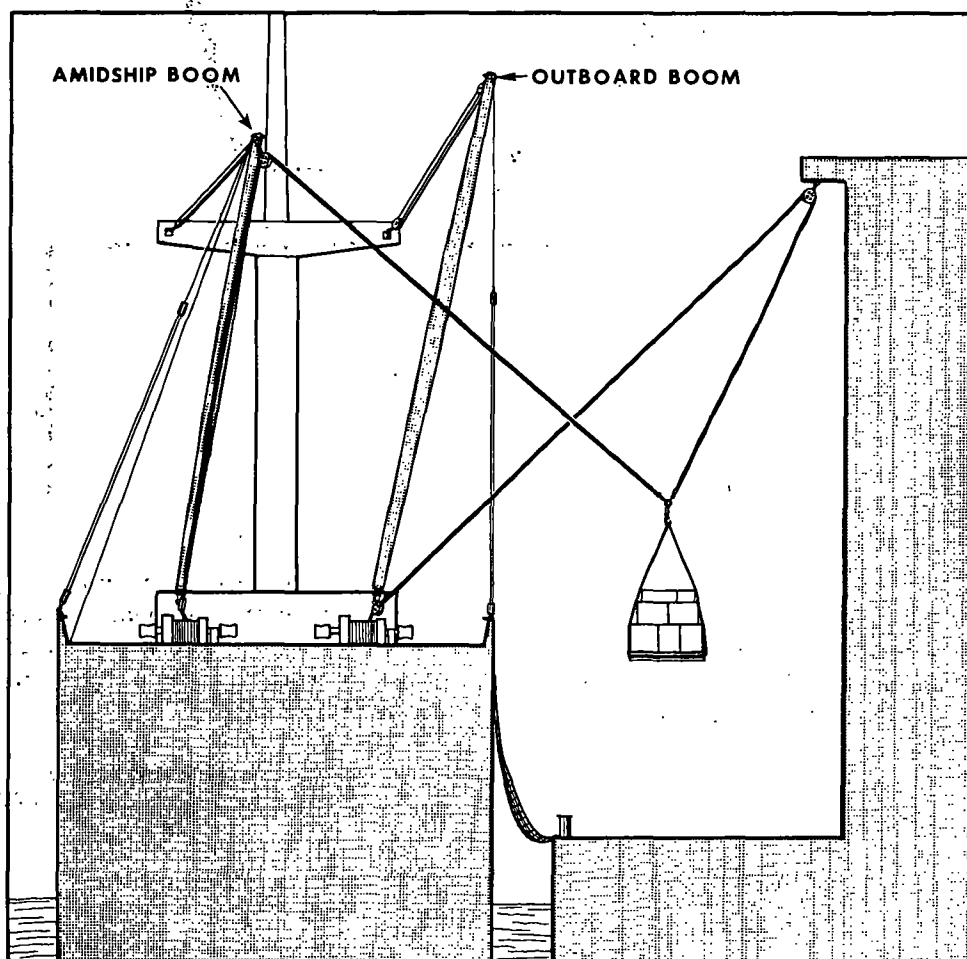


Figure 3-26. House fall.

b. Some of the advantages of the house fall are—

(1) On piers with narrow aprons, it eliminates the possibility of fouling the head of the outboard boom against the face of the pier shed.

(2) It provides a steady spotting area under the permanently installed block on the pier.

(3) On piers with second decks, it may provide the only means of working the second-deck platform because of the limited drift of the ship's booms.

(4) If the house-fall block can be made fast with sufficient height, it is possible to work extremely wide aprons with a spotting point at the doorway of the pier shed or at as many as three railroad spurs. When working with booms, it is sometimes difficult to work directly to railroad cars because the booms are too short.

3-18. Single Swinging Boom (fig 3-27)

a. Any of the following situations may require the use of a single swinging boom at a hatch:

- (1) Ship rigged with only one boom at each hatch.
- (2) One boom inoperative.
- (3) Large oversize light drafts.

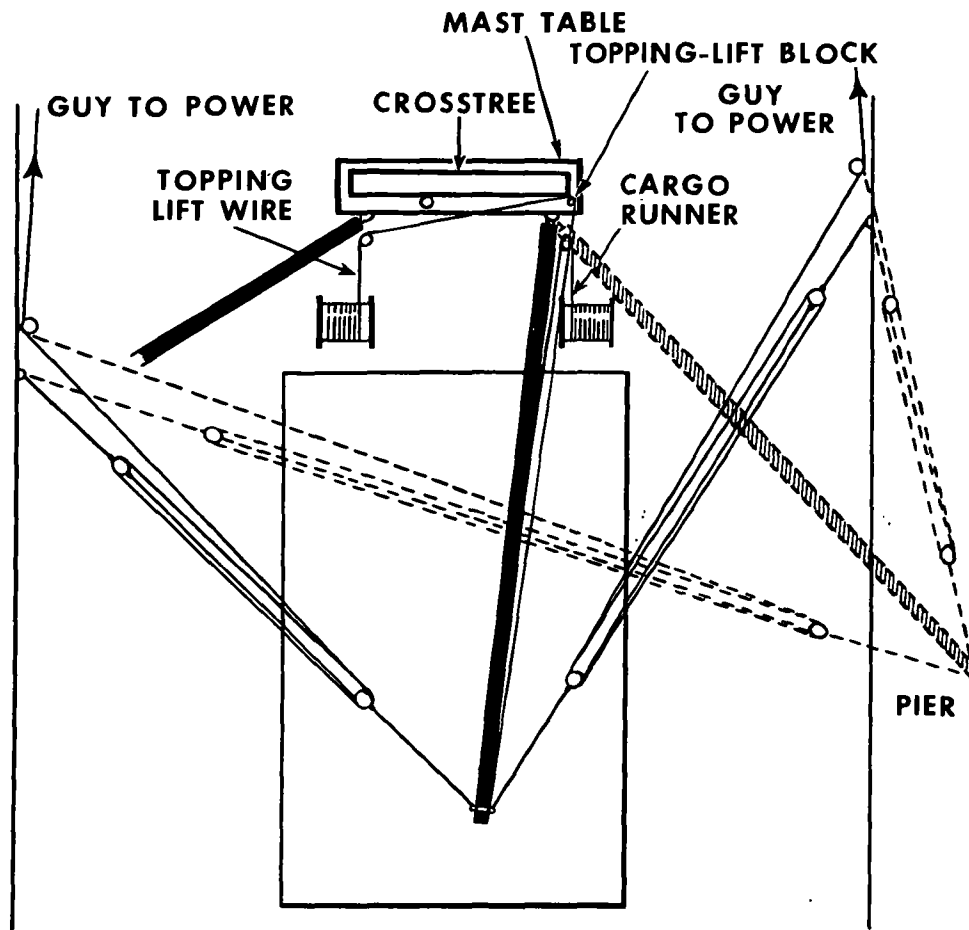


Figure 3-27. Single swinging boom.

b. Rigging a single swinging boom on a standard vessel so that the boom may be raised or lowered during the operation is accomplished as follows:

(1) The cargo runner on the boom not being used is run off the drum of the winch, and the boom is swung out of the way. The topping-lift wire of the working boom is fastened to the drum of the winch after the cargo runner has been removed.

(2) The winch serving the working boom is used to raise and lower the cargo runner on the working boom.

(3) In order to swing the boom from side to side, two guys are used, both being made fast at the head of the boom leading to the pad eye ring

on deck or on the rail. Power to move the boom from side to side can be furnished by using another set of winches, one for each guy. If power is not available, the boom may be swung by hauling on the guy tackle by hand.

c. Four sources of power are needed to operate a single swinging boom rigged in this manner:

- (1) One source raises and lowers the boom.
- (2) A second source raises and lowers the cargo fall.
- (3) A third source swings the boom to the right.
- (4) A fourth source swings the boom to the left.

d. Vessels having only one boom at a hatch will normally have a source of power to which to

attach the cargo runner, the topping lift, and the guys. Although the location of the power sources may differ from that on the standard vessels, the method of rigging is the same as described above; i.e., topping lift, cargo runner, and guys are led to power.

e. It is necessary in some cases to rig the single swinging boom so that it can be raised or lowered during the operation in order to obtain enough drift to clear the hatch coaming or the side of the ship. For handling regular size loads of general cargo on most vessels, it will not be necessary to lead the topping lift to power. The boom is spotted so that it plumbs the hatch when swung inboard and plumbs the desired landing spot on the pier when swung over the side of the vessel. Men are assigned to haul in or slack off the guy tackles. This method requires only three sources of power. The use of manpower to swing the boom in either direction makes it possible to work the single swinging boom with a single winch.

3-19. Safety Precautions

a. The following safety precautions for the operation of cargo booms should be observed:

(1) Do not run cargo runners across the hatch coaming.

(2) Do not handle drafts that exceed the safe working load of the rigging.

(3) Continuously check all rigging during cargo operations. This is the responsibility of the hatch foreman and deck men.

(4) Since the weight on a topping lift increases as a boom is lowered, instruct military cargo handlers to take sufficient turns on a cleat or cathead while the boom is high to insure having control of it when it reaches a low position.

(5) Exercise particular care to avoid overloading or putting shock loads on the cargo gear when the boom is at a low angle.

(6) Avoid letting a loaded boom rest against a stay, shroud, or other fixed object as the resultant bending may cause the bottom to fail.

(7) Inspect booms before starting work, and use any that are visibly bent with extreme caution because of their weakened condition. Before applying power to a guy, be sure that the gooseneck is free to turn by heaving on the guy by hand.

(8) Keep tension on married falls as low as possible during a lift. To avoid excessive tension on the guys—

(a) Use slings as short as possible.

(b) Keep the hook as close to the junction of the falls as possible.

(c) Keep the loads as close to the rail, deck, and coaming (as low) as possible.

(d) Avoid severe tightlining of even very light loads, as a difference of only a foot or two in the height of the load may increase the stress tremendously.

(e) Keep the heads of the two booms as close together and as high as possible to reduce the tension on the falls and therefore the guys. This is effective at any given height in the junction of married falls.

(9) Other rules for placing guys under minimum tension are—

(a) When the amidship boom angles inboard from its heel, place the guy at right angles to the boom, as seen from looking up from on deck.

(b) When the amidship boom is fore and aft, place the guy at a right angle to the boom when minimum tension is desired.

(c) When the boom angles outboard from its heel, place the guy abreast the heel or as far behind it as possible without permitting the boom to jackknife.

b. Determining whether or not amidship and outboard booms can top is discussed in paragraph 3-13 c (3).

c. Proper use of guys and preventers is discussed in paragraph 3-13 b.

Section V. RIGGING STANDARD BOOMS FOR HEAVY LIFTS

3-20. Safe Working Loads

a. Most ships are equipped with booms having a safe working load of at least 5 tons. The capacity of cargo booms is usually marked on the boom heel. If the safe working load is not marked on the boom, the ship's officers should be asked for this information.

b. Winches vary in capacity. The exact

capacity (leadline pull) can be ascertained from the manufacturer's nameplate on the machine or from a ship's officer.

c. Whenever the load to be hoisted by the yard-and-stay rig exceeds the safe working load of the rigging, an alternative rig must be employed that will increase the safe working load.

(1) Wire rope of 5/8- and 3/4-inch diameter is

most commonly used for cargo runners, but some vessels are equipped with 7/8-inch runners. The safe working load of 5/8-inch, 6.19 improved plow-steel wire rope is slightly more than 3 tons; 3/4-inch wire, slightly more than 4 tons; and 7/8-inch wire, slightly more than 6 tons. These safe working loads are for new wire. If the wire has been in use for some time or shows signs of wear, the safe working load must be reduced accordingly.

(2) There are many methods of rigging ordinary booms for heavy lifts, but practically all involve doubling up the cargo runner. This not only doubles the safe working load that may be picked up by the cargo runner, but it also decreases the strain on each winch by half. For a lift over 3 tons, 5/8-inch wire is doubled up. Although it is not necessary to double up a 7/8-inch runner to lift a 5-ton load safely, it may be necessary to double it up so that the winch will pull the load.

3-21. Single Swinging Boom With Double Purchase

a. A single swinging boom is rigged to handle loads within the safe working load of the cargo runner, but it is often necessary to lift loads that exceed the safe working load of the cargo runner.

Loads that are within the safe working load of the boom, but which exceed the safe working load of the cargo runner, may be safely lifted by rigging the boom as follows:

(1) Top the amidship boom and swing it out of the way, and lower the outboard boom to the boom rest.

(2) Fasten the topping-lift wire and the guys as described in paragraph 3-18.

(3) Equip the outboard boom with a runner long enough to permit doubling up. An additional 12- or 14-inch block is required.

(4) Reeve the end of the cargo runner through the 12- or 14-inch block and secure it by one of the following methods:

(a) Some booms are equipped with a heavy doubling-up pad eye (fig 3-28) about 4 feet from the head of the boom in line with the pad eye to which the headblock is attached. On this type, the eye splice in the cargo runner is shackled into the doubling-up pad eye. If available, a swivel may be made fast to the doubling-up pad eye, and the end of the cargo runner may be shackled into the swivel. This will reduce the tendency of the wire to twist by taking the turns out of the wire at the swivel.

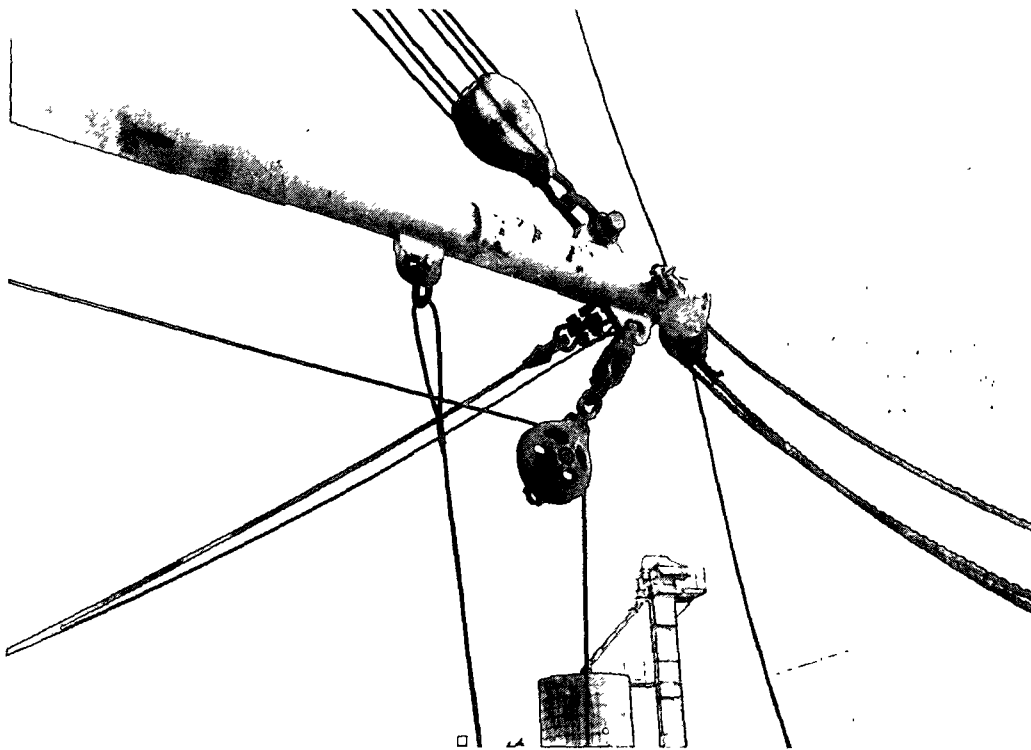


Figure 3-28. Doubling-up cargo runner using doubling-up pad eye.

(b) Most cargo blocks used aboard vessels are double becket blocks. Double becket blocks

are constructed so that shackles and swivels can be attached to both the top and bottom of the

blocks. Where these blocks are available and there is no doubling-up pad eye on the boom, the eye splice in the cargo runner can be shackled into the bottom of the cargo block (fig 3-29) or into a swivel attached to the block. It must be

remembered that the shackle or swivel at the bottom of the block must have a safe working load of at least half the weight to be lifted. A 5-ton lift would require a shackle $\frac{3}{4}$ -inch or larger.

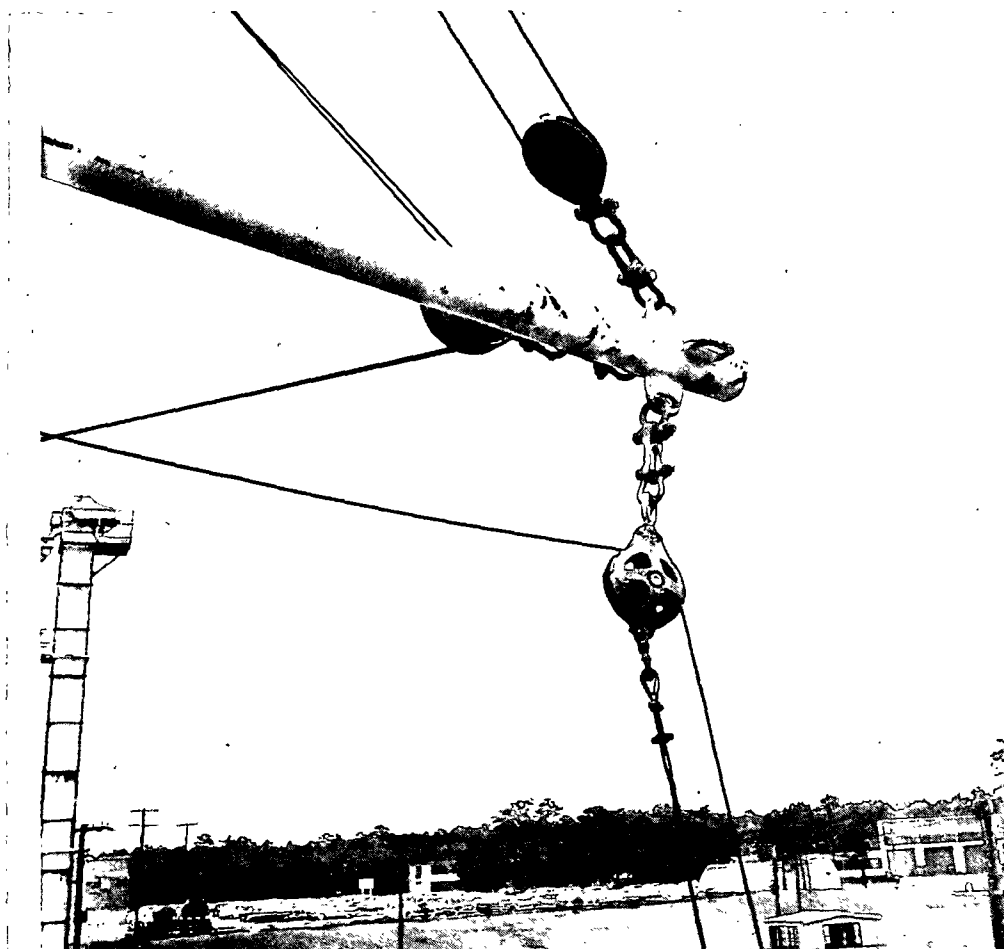


Figure 3-29. Doubling-up cargo runner using bottom of the block.

(c) If it is not possible to double up the rigging using either of the methods in (a) and (b) above, the runner may be secured to the boom by

taking two complete turns on the boom about 4 feet from the head of the boom and securing the eye splice to the link band (fig 3-30).

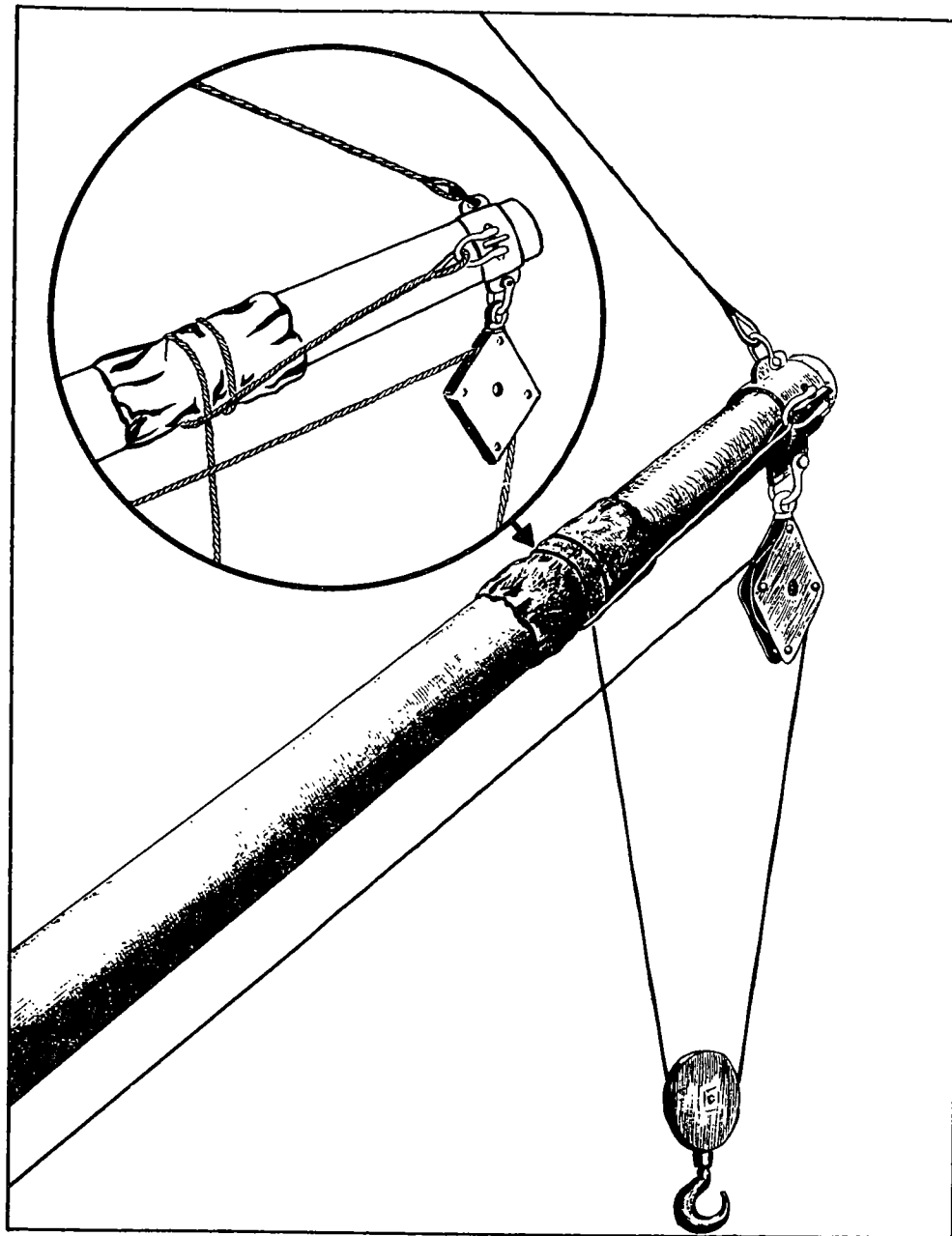


Figure 3-30. Doubling-up cargo runner by taking turns on the boom.

b. The boom is operated in the same manner as the single swinging boom, single-rigged (para 3-18).

3-22. Yard-and-Stay Rig With Double Purchase (fig 3-31)

a. Doubling up with a swinging boom greatly increases the time required to transfer the load from the pier to the ship or vice versa. Time can be saved by using fixed booms rather than

changing to a swinging-boom operation. This is especially important when many loads just over the safe limit are to be handled. One of the easiest methods of augmenting the load limit is to rig both booms with a double purchase. This requires two additional 12- or 14-inch blocks. In working this rig, guys and preventers must be in excellent condition and equalized as nearly as possible.

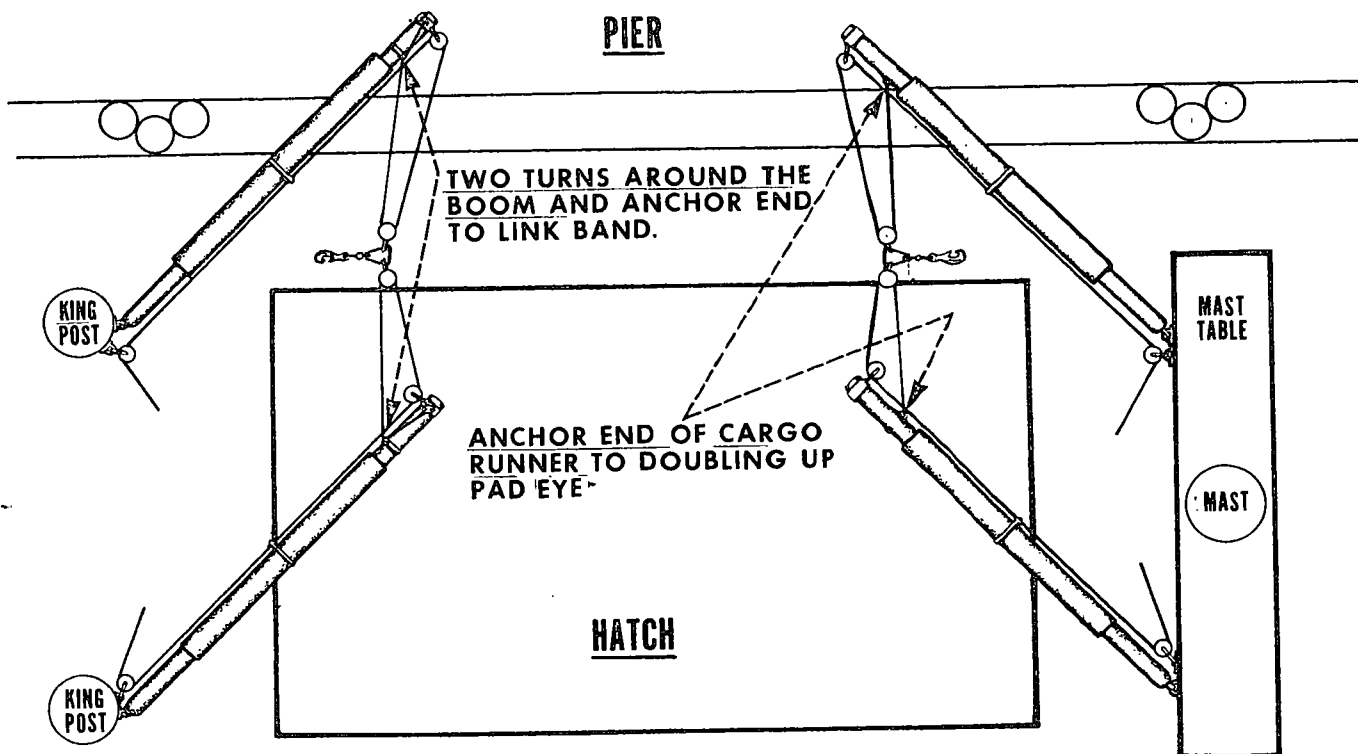


Figure 3-31. Yard-and-stay rig with a double purchase.

(1) The cargo runner of each boom is doubled up by any of the three methods described in paragraph 3-21. If the doubling-up pad eye on the boom is used, the hauling part of the cargo runner must be on the inside. If the cargo runner is secured to the boom by turns, the turns must be started on the inside of the boom so that the hauling part of the runner is on the inside. These precautions prevent the hauling part from chafing against the standing part because the hauling part leads from the heelblock to the headblock.

(2) When both booms have been doubled up, the two traveling blocks are married by shackling in a standard cargo hook assembly. The booms are topped, spotted, and worked as in a regular yard-and-stay operation.

b. The chief advantages of this method of rigging are:

(1) Lifts as heavy as the safe working load of the cargo boom can be handled at about half the rate of ordinary 1- or 1½-ton drafts.

(2) Light filler cargo can be handled without stopping the operation to single up the rigging.

3-23. Block-in-Bight Rigging on Double-Rigged Hatch

a. Handling heavy lifts at a hatch rigged with two pairs of ordinary cargo booms is facilitated by rigging all four booms as illustrated in figure 3-32. The procedure is as follows:

(1) Reeve the runner of the forward amidship boom through a 12- or 14-inch block, and shackle eye-to-eye with the runner of the after amidship boom.

(2) Reeve the runner of the forward outboard boom through a 12- or 14-inch block and shackle eye-to-eye with the runner of the after outboard boom.

(3) Hoist the shackles of the two sets of runners aloft to within a few feet of the headblocks of the after booms.

(4) Marry the two blocks together for regular yard-and-stay operation.

(5) Be sure that booms are properly spotted and guys and preventers are equalized.

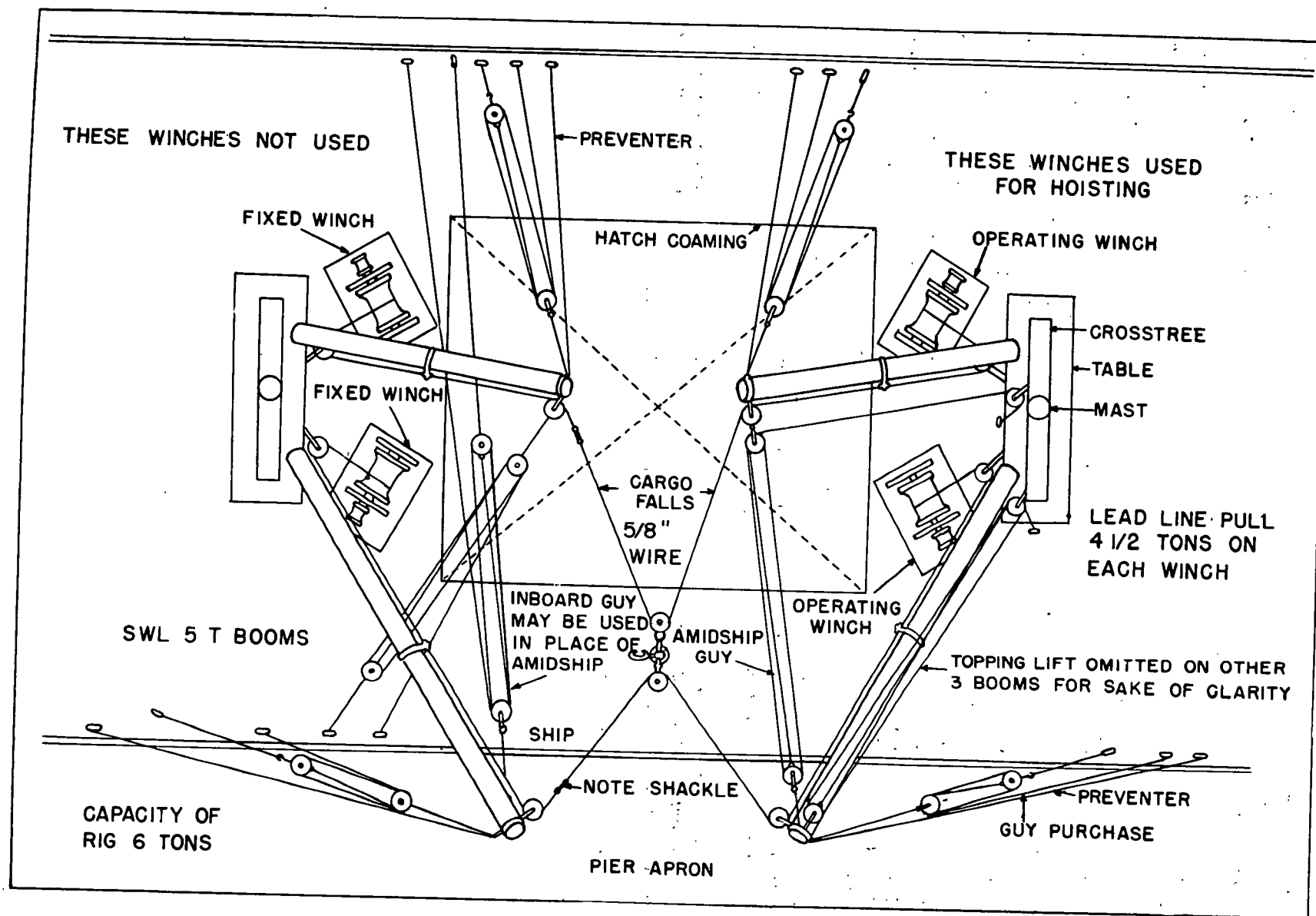


Figure 3-32. Block-in-bight method of rigging four booms

b. Heavy lifts not exceeding the safe working load of two parts of the cargo runner, the guys and preventers, or the combined safe working load of two booms may now be loaded or discharged by the usual yard-and-stay method. This type of rigging has the advantage of being quickly rigged without the necessity of lowering booms. Moreover, only two winches are required, and the gear may be readily singled up for ordinary light drafts.

c. Many modern vessels are equipped with topping-lift winches which are used only for topping or lowering the booms. When the boom is spotted, the winch is shut off and the topping-lift wire remains on the winch. This permits the booms to be raised or lowered rapidly simply by operating the topping-lift winches. Almost all heavy lift operations require a dragline operation. Therefore, if topping-lift winches are available, double-rigged hatches may be rigged with the block-in-bight method as described below:

(1) Lower the booms on the after end of the hatch and remove the runners and headblocks from the booms.

(2) Reeve the cargo runners of the forward booms through 12-or 14-inch blocks, and shackle the runners to the link band of the opposing booms.

(3) Marry the two doubling-up blocks for

regular yard-and-stay operation and raise the after booms to the desired height.

(4) Spot the booms and make certain that guys and preventers are equalized.

(5) Heavy lifts may now be worked as described in *a* above, using the winches at the forward end of the hatch. The winches at the after end are available for dragline operations exclusively.

d. The method described in *a* above can be rigged much faster than that described in *c* above. However, the time lost in lowering and raising the booms by using the topping-lift winch will be more than made up by having two winches available for dragline operations. Lifts landed in the hold can be quickly moved to their stowage place in the ends or wings of the hold during loading or into the square of the hatch during discharge. The dragline operation can be going on while the previous load is moving to or from the ship and while the men are hooking on the next load or unhooking the previous load.

3-24. Four Booms Doubled Up on Double-Rigged Hatch (fig 3-33)

a. Winch operators must be highly skilled for this operation. This method should not be used except in case of emergency.

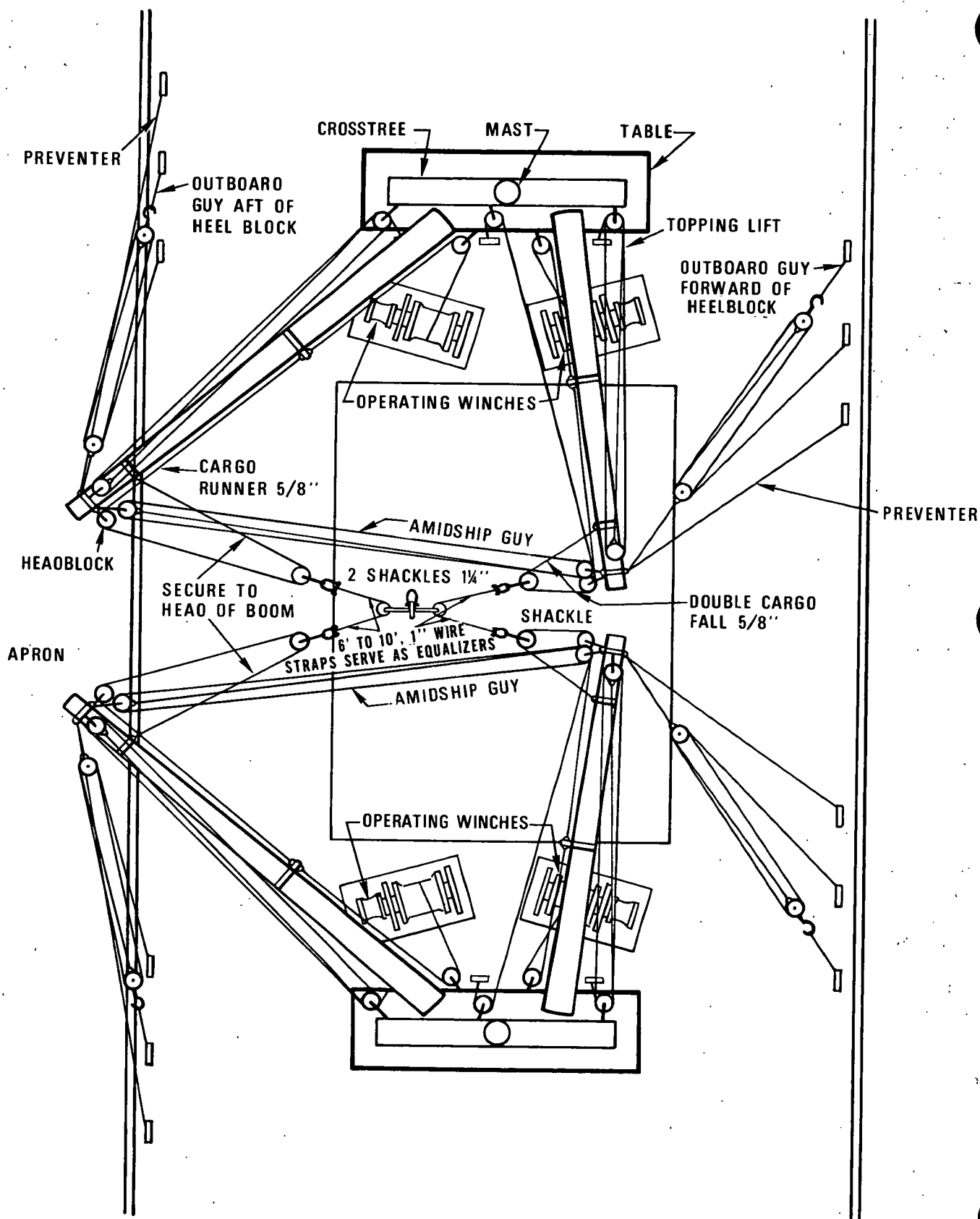


Figure 3-33. Rigging four booms with a double purchase.

b. The method of rigging on a double-rigged hatch will handle loads up to the combined safe working load of two booms, provided the safe working load of two parts of the cargo runner equals or exceeds the combined safe working load of two booms. To lift a load of 9 long tons on a double-rigged hatch using the block-in-bight method requires the use of 7/8-inch cargo runners. The safe working load of two parts would be approximately 10 tons. However, it is possible to handle a 9-ton lift on a double-rigged hatch using smaller cargo runners by doubling up all four booms. This method is described below:

(1) Double up the runners of all four booms by reeving the ends of the runners through 12- or 14-inch blocks and securing to the head of the boom as described in paragraph 3-21a (4).

(2) Marry the doubling-up blocks of the two outboard falls using a 1-inch wire strap reeved through a 14-inch block.

(3) Marry the doubling-up blocks of the hatch falls using a 1-inch wire strap reeved through a 14-inch block.

(4) Shackle these two blocks together, using shackles 1 1/4 inches or larger.

(5) Check all guys and preventers carefully to make sure they are correctly placed and equalized. The two 1-inch wire straps that are reeved through blocks joining the outboard falls and the hatch falls serve as equalizers in case the winches are not synchronized in making the lift.

c. If the booms are equipped with inboard guys instead of amidship guys, the inboard guys should be led outboard to further strengthen the outboard guys. The weight of the blocks and the load will keep the booms from swinging outboard. The lift should be carried close to the deck to avoid a fiddlestring pull.

d. Use yard-and-stay rig.

3-25. Safety Precautions With Heavy Lifts

a. The operation of cargo booms rigged for heavy lifts requires skill, judgment, and commonsense. Signalmen and winch operators must understand that the load should be plumbed underneath the boom before it is picked up. They must know the importance of taglines in checking the swing of heavy drafts and must be familiar with the safe working load of all types of rigging and slings.

b. In working heavy lifts, all standing and running rigging and deck fittings must be checked frequently to detect unusual wear or chafing.

(1) The cargo runner must be firmly secured to the drum of the winch. This can be done by

reeving the end of the runner through the hole in the drum of the winch, out through the opening in the side of the drum, and twice around the shaft. The runner may be secured either with a rope yarn or wire clamps, but the latter method is recommended. As an additional precaution, winchmen should never operate with less than three turns around the drum of the winch.

(2) Shackles, hooks, and gates of snatch blocks used in rigging should be secured with wire or rope before operation, and they should be checked during operation to be sure that they remain in safe condition. In mousing a shackle, the pin should be tightened and secured with rope yarn or wire.

(a) In all cases where rigging is aloft, wire should be used for mousing; care should be exercised not to place mousing where it may be cut by the wire rope as it passes the shackle.

(b) Hooks are moused to prevent slings from slipping off the hook and to prevent hooks from slipping off rings and other fittings. Hooks may be moused by rope yarn or wire, and shackles may be used on certain types of hooks.

(c) Unless firmly moused, the gates of snatch blocks may open, allowing the wire to jump out. Many snatch blocks are fitted with a locking pin which, if available, should be used.

c. In making a heavy lift, all men in the hatch section must be alert for failures in the gear and other possible hazards. Bridles, slings, and other lifting devices must be thoroughly inspected. The safe working load of any rigging is limited by the safe working load of the weakest part of the rigging; this includes the slinging or lifting devices. The time and effort spent to rig booms for a safe working load of 10 tons would be wasted if an attempt were made to pick up a 10-ton lift using a 5/8-inch wire rope sling.

d. Before a heavy lift is hoisted, it should be picked up a few inches and thoroughly inspected. The slings should be checked and, if necessary the draft should be lowered and the slings adjusted or blocked off with dunnage to prevent chafing of the wire or damage to the lift. While the load is suspended off the deck, the rigging (including the booms, topping lift, runners, and guys) should be carefully observed for indications of unusual strain.

e. After everything has been found to be in order, the draft should be hoisted slowly in one continuous operation. All blocks should be running free. Listen to the gear while the lift is being made. A faulty block, wire, or rope under strain sometimes squeaks and groans loud

enough to give warning to the alert man, although not always.

f. In relation to the (nonjumbo) boom, where there is a choice of a tall or a short mast, with correspondingly high and low topping lift blocks, is safer to lift heavier loads such as lift trucks with the gear on the longer mast.

g. In using the jumbo boom, lower it to the lowest position which will enable it and any draft to safely clear all obstacles. Avoid swinging it at a near vertical angle.

h. Guy winch operators and men handling the guys on a jumbo boom should both have the signalman in clear sight at all times and should be instructed to stop heaving if at any time the stress on the hauling part appears to be excessive.

i. A check should be made with the mate before making a heavy lift with the jumbo boom to find out whether auxiliary stays need to be set up.

Section VI. HEAVY LIFT BOOMS

3-26. General.

Tanks, landing craft, tugs, picket and patrol boats, and other extremely heavy cargo required by the Armed Forces in the field present complex problems in cargo handling operations. At loading terminals in the United States, loading a heavy lift is a fairly simple operation. However, at oversea bases, shoreside equipment or floating cranes are not always available. Often the ship's gear must be used for discharging heavy lifts. Many modern ships are equipped with one or two jumbo booms having capacities of 50 to 120 tons. They are generally located at the larger hatches of the vessel. Many ships used in task-force operations, particularly in securing beachheads, are equipped with heavy lift gear at practically all

hatches for quick discharge of heavy equipment like landing craft, tanks, and bulldozers. A few American ships specially fitted for heavy lifts have jumbo booms with capacities up to 240 tons. All terminal operations personnel operating in the field will have occasion to operate heavy lifts. For this reason, the rigging and operation of the jumbo boom must be understood.

3-27. Methods of Rigging

a. Most heavy lift booms are fully rigged with topping lifts, purchases, and guy tackles already secure. In order to save space on deck for cargo, the jumbo boom is generally carried in an upright position against the mast (fig 3-34).

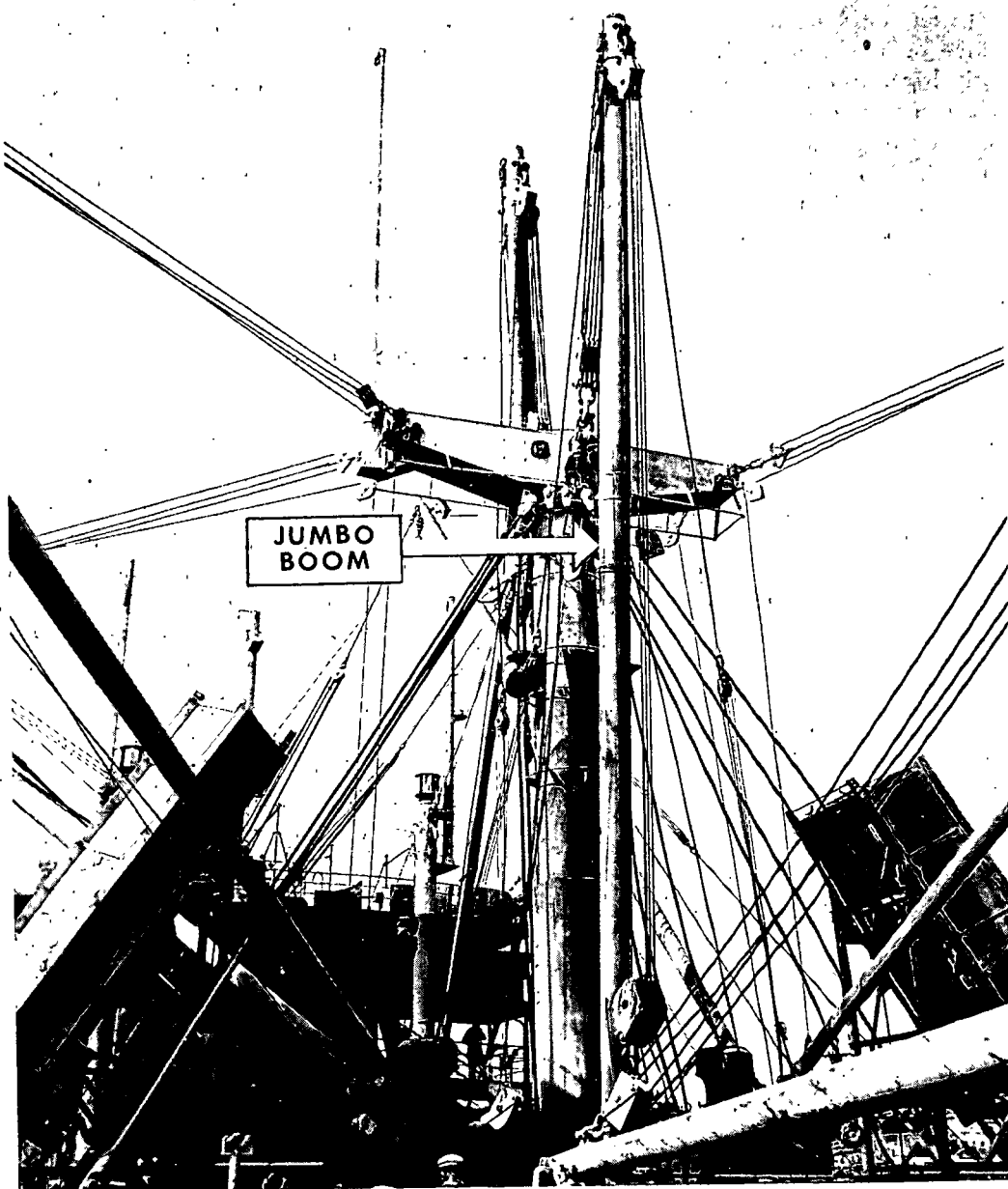


Figure 3-34. Jumbo boom in upright position.

b. The first step in rigging the jumbo boom is to lead all purchases to power.

(1) Sources of power are required—

(a) For the cargo fall to raise and lower the cargo hook.

(b) For the topping lift to raise and lower the boom.

(c) For each guy tackle to swing the boom from the hatch opening to the pier and return.

(2) If only two winches are located at a

hatch, the two additional sources of power may be supplied by the anchor windlass, the warping winch, or winches at an adjacent hatch. On double-rigged hatches, the winches on the opposite end of the hatch may be used.

(3) Sources of power are normally used as follows:

(a) The cargo runner is led through a heelblock to one winch at the hatch worked (A, fig 3-35).

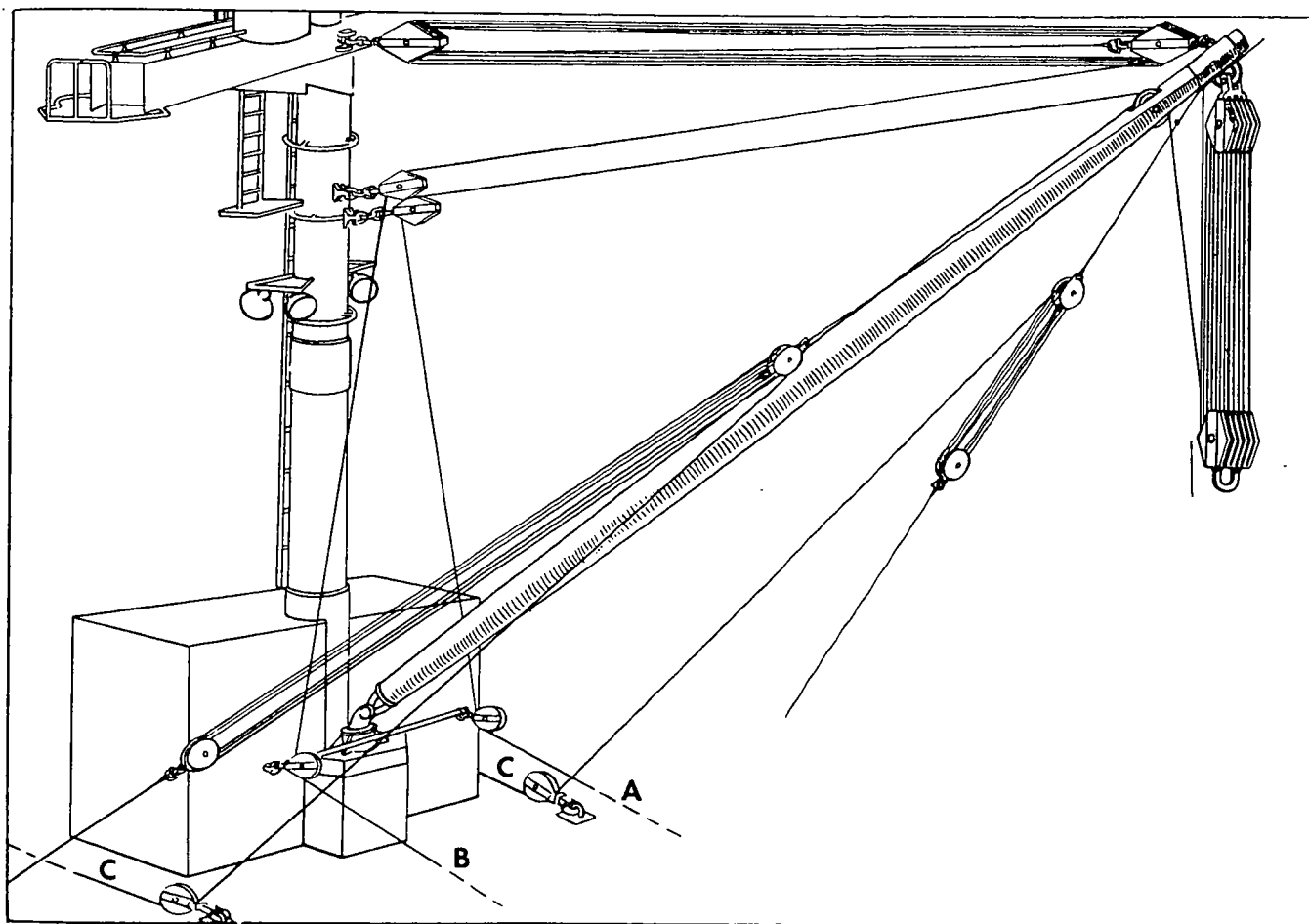


Figure 3-35. Typical jumbo boom.

(b) The topping lift is led through another heelblock to the second winch at the hatch being worked (B, fig 3-35).

(c) The two guys are shackled to pad eyes, and the hauling parts of the guys are led through a series of snatch blocks to the additional sources of power (C, fig 3-35).

c. At this point, all purchases have been led to power and the guys have been made fast, but the boom is still held fast to the mast. The shrouds and stays should be checked, secured, and tightened if necessary.

d. The next step is to remove the collar or lashing that holds the boom to the mast. This is accomplished as follows:

(1) If possible, take a strain on the topping-lift wire to release the pressure on the collar or lashing. In vessels where this is not possible, use a breasting-up line in the following manner:

(a) Make the breasting-up line fast to the boom, either by passing it around the boom or shackling it into a pad eye that may be on the boom for this purpose. Pass the line through a

snatch block on the mast, and fairlead it to the cathead on the winch.

(b) Take a strain on the breasting-up line and release the collar or lashing that holds the jumbo boom in place.

(c) Slack off the line slowly until the weight of the boom is on the topping lift.

(d) Remove the breasting-up line, and lower the boom into position with the topping lift.

(2) In either of the methods in (1) above, men must be sent aloft to release the boom.

3-28. Guying Heavy Lift Boom

a. The rated capacity of a boom is the safe load that it will lift only when it is properly rigged, guyed, and operated and when the stays are properly placed. Care must be taken in rigging to prevent undue strain on the boom and the guys.

(1) On single-rigged hatches, it is usually advisable to use the anchor windlass for the forward jumbo boom and the mooring or warping winch for the after jumbo boom, leading one guy over the top of one cathead and the other guy

underneath the other cathead so that one guy is pulling while the other is slacking off. The guys should be tended by experienced men, and the direction of rotation of the winch or windlass should be clearly understood by all so that when the proper signals are given, a slow, smooth operation will result with minimum strain on the takeup guy and proper slack on the following or slacking guy.

(2) On double-rigged hatches, the guys may be led to the winches on the opposite end of the hatch.

b. As the guys approach the vertical, the strain on the guys and the boom increases while the angles between the guys and the boom decrease. To place the guys properly, the guy with the greatest strain should be given the largest angle between the guy and the boom. Figures 3-36 and 3-37 show the horizontal strains involved when the guys are placed on a heavy lift

boom for loading from or discharging to a pier. For example, assume that the ship is being unloaded. The outboard guy has been so placed that the angle between the guy and the boom is 15° in figure 3-36 and 5° in figure 3-37. Assume that a 3,000-pound pull (indicated by the letter P) is placed on the inboard guy while the brakes are applied on the outboard winch. In figure 3-36 the strain would be approximately 4,230 pounds on the inboard guy and approximately 11,580 pounds on the outboard guy. In figure 3-37, the inboard guy would have the same strain as in figure 3-36 but the outboard guy would have a strain of approximately 34,500 pounds. Thus, decreasing the angle between the outboard guy and the boom by 10° triples the strain. Shifting the outboard guy (fig 3-36) too far forward will cause too steep an angle with the boom, particularly if the boom has to be raised to handle cargo in the after part of the hatch.

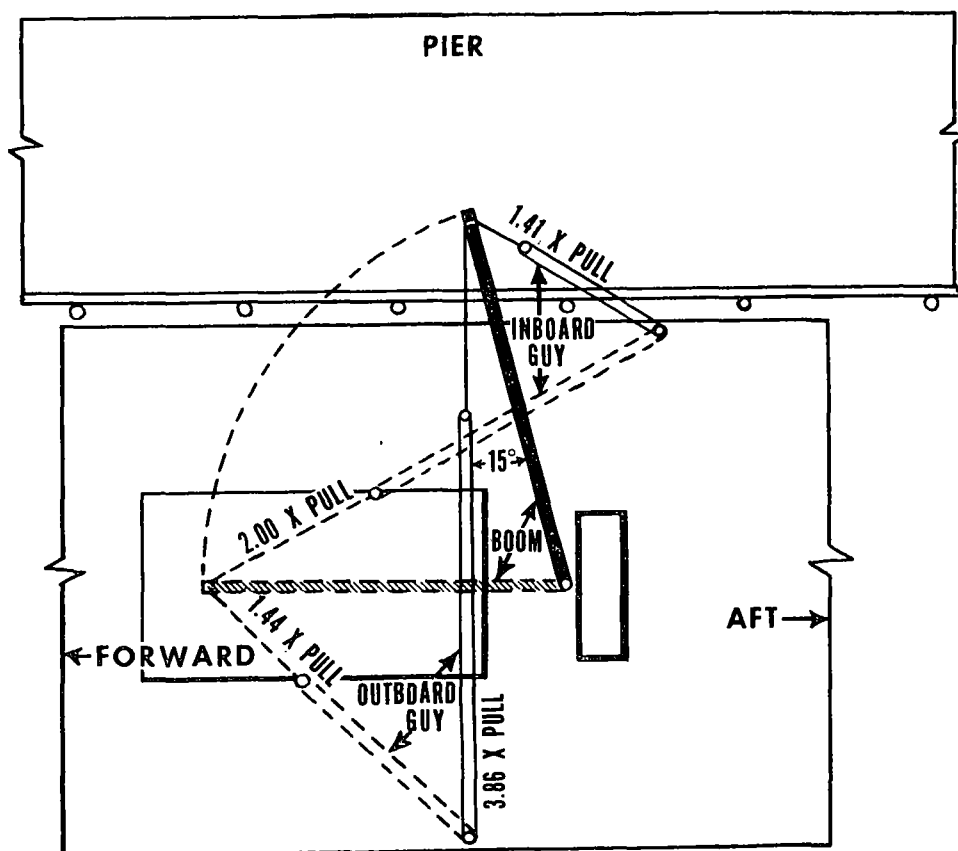


Figure 3-36. Proper guying of jumbo boom.

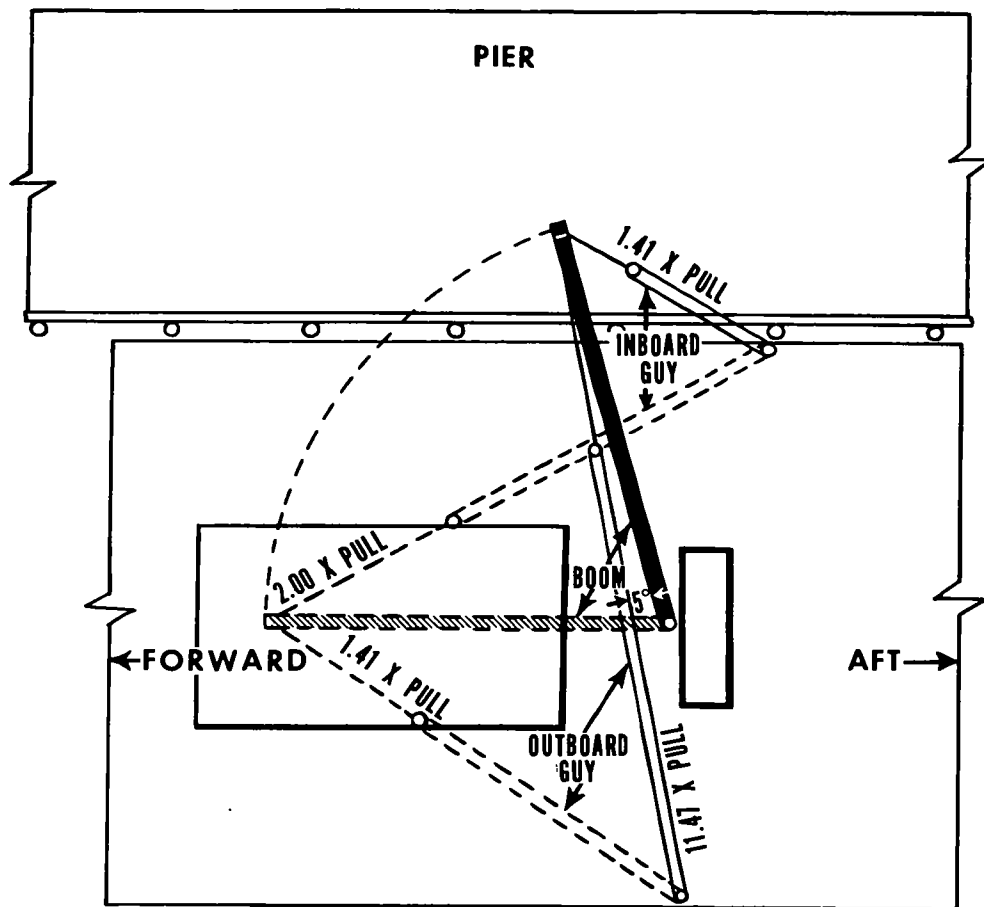


Figure 3-37. Incorrect guying of jumbo boom.

3-29. Operating Heavy Lift Boom

a. Before operating the jumbo boom, swing the standard hatchbooms clear of the working area. Generally, it is sufficient to swing these booms against the shrouds and shrouds and secure them with their guys or it may be necessary to top them when working deck cargo.

b. Check gear thoroughly to insure that—

- (1) Blocks are running free.
- (2) No lines are chafing.
- (3) The turns on the winches lie evenly.
- (4) Snatch-block gates are securely moused to prevent opening.

(5) Guy tackles are free of twists and are guided through fairleads to sources of power.

(6) Stays are secured and tightened.

c. Insure that signalmen, winchmen, and men tending guys clearly understand all signals. Additional signalmen may be necessary to relay signals to men tending guys at the windlass or warping winches; however, the number of signalmen should be kept to a minimum.

d. Sling the draft carefully and shackle the slings into the traveling block on the cargo

runner. After a final check to see that everything is secure, hoist the draft a few inches off the deck and recheck all rigging.

e. Avoid faulty winch operations, sudden stops, and quick starts. Properly planned heavy lift operations move slowly and smoothly.

f. Carefully hoist the draft until it clears the hatch coaming and rail.

g. Adjust the angle of the boom by taking up or slacking the topping lift.

h. Every change in direction of the boom requires an adjustment of the guys. As the boom is raised, slack off the guys; as it is lowered, tighten the guys.

i. The boom is swung by taking up on one guy and slacking the other. When working a jumbo boom, give close attention to handling the guys. When a boom is swung either inboard or outboard, one guy is the hauling guy and the other is the following guy. Just the right amount of slack must be maintained in the following guy to prevent undue strain on the hauling guy. Too much slack in the following guy might allow the draft to get away.

j. Use the following guy to control the boom's tendency to swing in the direction of the list which occurs in a tender ship when a load is swung outboard.

k. Lower the draft by slacking the cargo runner.

3-30. Modern Jumbo Booms

a. Technological advances have increased the ability of a single jumbo boom to handle heavy cargo loads at either of two adjacent holds. These booms have been put on a limited number of new ships; they also be installed on ships already in operation.

b. The adjacent hold operation is accomplished with one boom and related gear located between the two hatches. The boom is stepped on a ball-and-socket heel assembly and is supported at its upper end by twin topping lifts from rotating heads on two unstayed king posts. The boom heel is provided with a ball pivot heel fitting which permits a 3° port or starboard tilt of the boom head when being passed between king posts to the opposite hatch. A winch is provided for each of the two topping lifts. The split topping arrangement provides quick and accurate positioning of the boom throughout its travel, inboard or outboard, of the vessel. The upper block of the cargo falls is supported from a rotating sleeve near the head of the boom and the hauling part is led to a swivel block and winch near the base of the boom. The lower block of the cargo falls is weighted and fitted with a hook or other attachment, as desired.

c. Positioning the boom is accomplished by operating the topping lifts. The desired position of the boom can be reached by operating the topping lift winches so as to properly take in and/or pay out on the topping lifts.

d. Shifting the boom from one hold to the other is accomplished in the following manner:

(1) Swing boom to centerline of ship.

(2) Raise boom until nearly vertical (about 85°), keeping boom at centerline of ship. A limit switch can be set to cut off topping winches when boom is raised to 85° above horizontal.

(3) Suspend lower cargo hoist block to a position accessible from the winch house.

(4) Secure the handling pendant to the lower cargo hoist block and raise lower block to about 10 feet from the upper cargo block, and pass pendant through the opening in the king posts and outboard to portside of the cargo hoist hauling part.

(5) Haul in on cargo falls until the boom head and cargo blocks rotate and the boom passes through the opening of the king post and repositions itself at 85° toward the adjacent hold.

(6) Reverse this procedure to move the boom back from the adjacent hold to the original hold.

e. Certain cautions should be observed when working these jumbo booms.

(1) When swinging a loaded boom, swing the boom outboard of the ship slowly while observing the topping lifts and ship's list.

(2) Do not swing boom outboard beyond 70° from ship's centerline or beyond a point where the boom's outboard topping lift shows evidence of slackness.

(3) When shifting the boom between holds, station an observer on the ship's centerline to assist the winch operator in keeping the boom centered between the king posts (within 3°, port or starboard). Do not overload topping lifts as boom nears vertical position.

Section VII. HATCH TENTS AND SAVE-ALLS

3-31. Hatch Tents

a. *Purpose.* Hatch tents are large canvas shelters suspended from the heads of the booms to protect cargo and men during inclement weather. Hatch tents are frequently used in areas which have a rainy climate. They may also be used for shade during extreme heat, especially

when discharging refrigerated cargo. Hatch tents give only partial protection, so when work is discontinued, the hatch should be closed and battened to give the cargo better protection. The Seattle hatch tent (fig 3-38) is the best all-purpose hatch tent, because it completely covers the hatch.

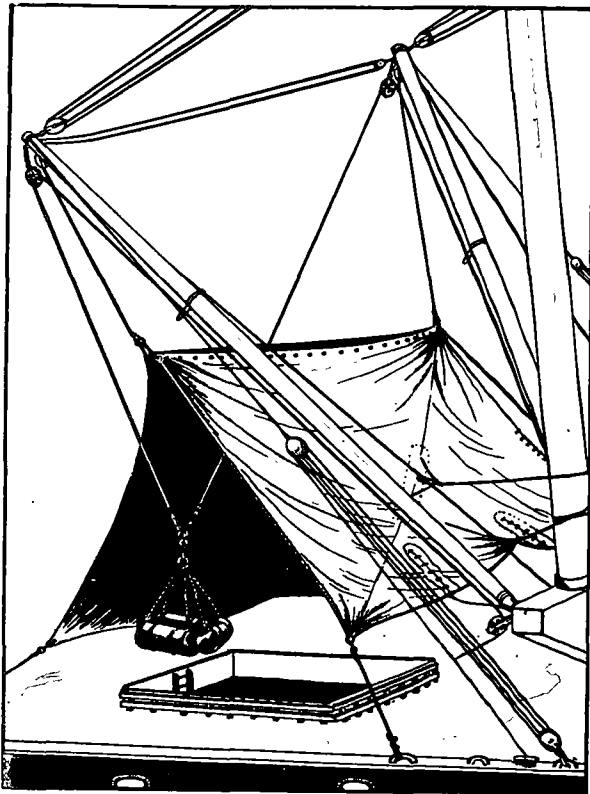


Figure 3-38. Seattle hatch tent.

b. Rigging.

(1) The first step in rigging a Seattle hatch tent is to secure the gantline to the head of each boom. The gantline is a length of rope, 3½ inches in circumference which is reeved through a 10-inch wooden block secured to the link band at the head of each boom. These blocks hang on the offshore side of each boom; from the wharf, both blocks appear on the sides of the booms away from the wharf.

(2) After the tent is hoisted aboard using the ship's falls, the hatch boom gantline is tied to the

large shackle attached to the metal shoe in the rear peak of the tent. The tent should be spread out while it is being raised. The hatch runner is inserted in the opening between the ridges of the tent and then the hatch gantline is heaved up until the bottom of the tent is above the deck. The heavy backstay of the tent is pulled taut, and the gantline is secured.

(3) The front of the tent is hoisted by using the outboard fall and gantline. After the fall is removed from the shackle, hoisting is continued on the gantline until the ridge of the tent is straight and parallel with the deck. The outboard gantline is then secured.

(4) The final step consists of spreading the tent over the hatch opening. The guy lines on the corners and center of the sides and back are tightened and secured. The intermediate lanyards are adjusted to keep the tent straight and to prevent sagging.

(5) The Seattle hatch tent is designed with reeve points and laced-up flaps so that it can be adapted to hatches of practically any size. The flaps are unlaced, forming a protective shelter for the winchmen.

3-32. Save-Alls (fig 3-39)

a. Save-alls are used to prevent the loss of cargo overboard during loading and discharging. They should be rigged at each working hatch and beneath each gangplank, skid, or conveyor. The most common type of save-all is a rope net. The type found in the general hatch set is made of manila rope and is 20 by 40 feet, with 8-inch square meshes. If a standard save-all is not available, substitutions may be made. For example, wire or rope cargo nets may be lashed together, or wooden platforms can be constructed and made fast between the ship and the pier under the working area.



Figure 3-39. Save-alls.

b. The normal method of rigging a save-all is to use the ship's falls as listed below:

- (1) Hook the top center of the net and then hoist it until even with the ship's rail.
- (2) Then secure the lanyards or lashings to cleats on board and slack off the net.
- (3) Secure the bottom of the save-all to the stringer on the pier.

c. Sufficient slack should always be left in the save-all to prevent it from being carried away when the tide or current moves the ship higher or lower or away from the pier. Where extremely high tides are common, the lashings should be slacked off or tightened frequently during the change of tide.

Section VIII. RIGGING EXPEDIENTS

3-33. Damaged Ship's Gear

Since overloading or improper maintenance may cause failure of the ship's gear and enemy action could damage or destroy cargo handling facilities, terminal operations personnel must be prepared to discharge cargo under the most adverse operating conditions.

3-34. Improvised Falls Over Hatch

a. A disabled or broken amidship boom can often be replaced by rigging a stay tackle over the square of the hatch and hanging an ordinary headblock from the stay. Figure 3-40 illustrates the use of this method on No. 1 hatch.

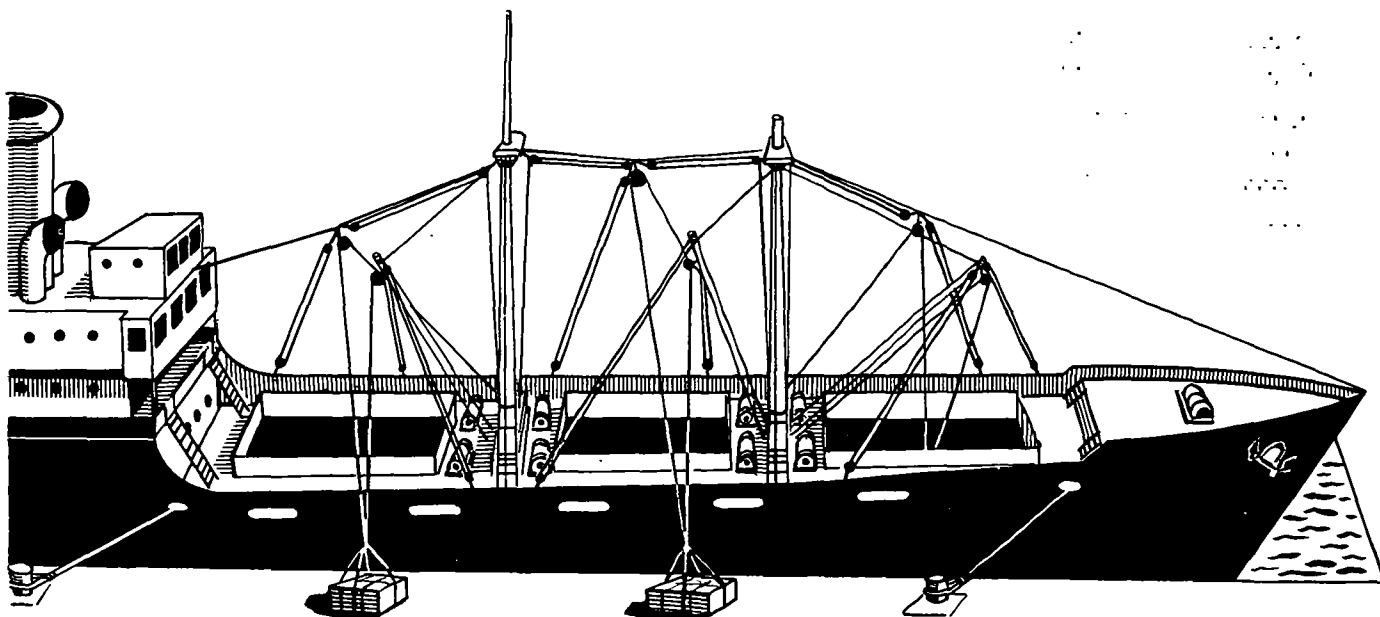


Figure 3-40. Improvised falls over hatches.

(1) A stay is rigged from just above the crosstrees of the foremast to a point on the forecastle head. The anchor windlass is a good place to secure the stay using the cathead to take the slack out of the wire. Another method is to secure the wire to bitts and use a turnbuckle to remove the slack.

(2) The stay should be of good quality 7/8- or 1-inch wire rope. If lighter wire is used, the safe capacity of the gear is reduced accordingly.

(3) After the stay has been erected, an ordinary block through which the cargo runner is reeved is shackled to the wire, hauled up the stay by the block and tackle to a point over the square of the hatch, and secured. The cargo runner is then married at the hook with the outboard boom runner, and operations can progress in a typical yard-and-stay method.

b. No. 2 hatch can be rigged similarly to No. 1 hatch, with the following exceptions:

(1) Two blocks and tackle are required to spot the headblock over any position in the hold below.

(2) The slack can be taken out of the stay either by leading it through a block on the crosstrees to the cathead (fig 3-40) or by using a turnbuckle aloft.

c. A stay over No. 3 hatch can run from any secure point atop the bridge to the head of the main mast. It is advisable to back up the block hung on the stay with a guy tackle led to the offshore rail of the ship. This prevents undue strain on the stay when the load is racked across the deck.

3-35. Using Boom at Adjacent Hatch

a. If one of the modern jumbo booms discussed in paragraph 3-30 is not available, and one boom at a hatch is inoperative, it is often possible to use a boom from an immediately adjacent hatch. This method is only practical when there is a small amount of cargo in the hatch with the damaged boom and the boom on the other hatch is not being used. Rigging for this type of operation is as follows:

(1) The boom at the hatch being worked is spotted over the hatch.

(2) The boom at the adjacent hatch is spotted over the pier.

(3) The cargo runners are married together as for regular yard-and-stay operation.

(4) Both booms are rigged with an inboard and an outboard guy. If they have previously been rigged with an amidship guy, it should be removed. The outboard guys can be removed from the inoperative booms and used as inboard guys on the two working booms.

b. If there is a considerable amount of cargo in the hatch when one boom becomes damaged, a better solution would be to work the cargo out of the hatch with a single swinging boom (para 3-18) until one of the other hatches has been unloaded. The damaged boom can then be physically replaced with one from the completed hatch. Although booms at different hatches may vary in length, the discharging operation can be carried out because the gooseneck fittings are the same size in most cases.

c. The methods in *a* and *b* above can be used for loading if no other means are available.

3-36. Improvised House Fall

An improvised house fall can take the place of a disabled boom. Materials required include stout

piling or poles to be used as vertical members and substantial lengths of wire or rope for guys and stays. Figure 3-41 illustrates one method of rigging and improvising a house fall.

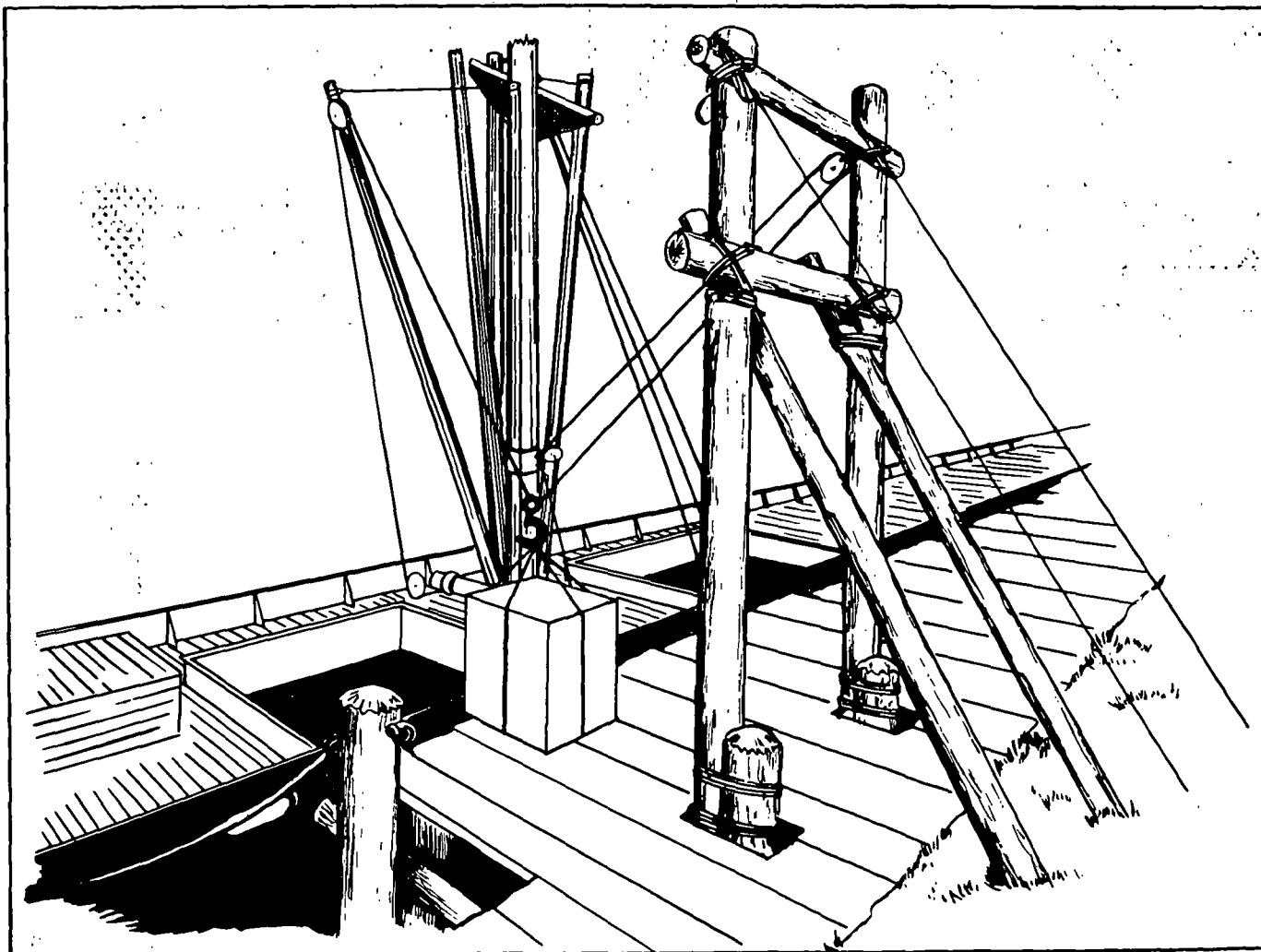


Figure 3-41 Improvised house fall.

3-37. Yard-and-Stay Jury Rig

a. The yard-and-stay jury rig may be used at a hatch when power from only one winch is available (fig 3-42). It is slow by comparison with

the usual yard-and-stay operation and is recommended only as an expedient until normal operations can be resumed.

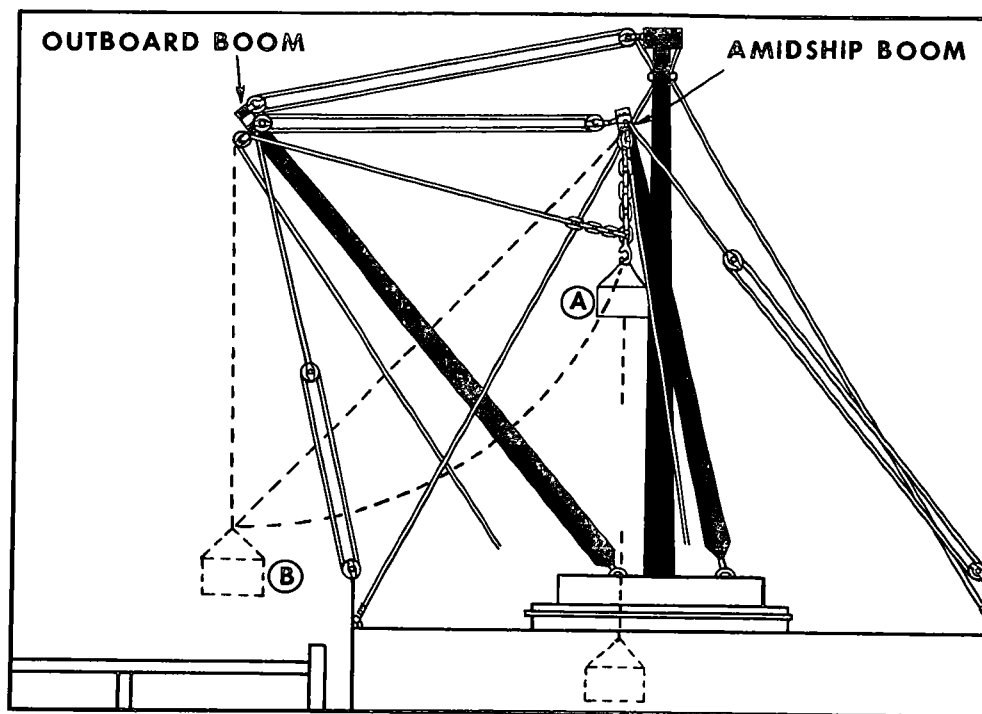


Figure 3-42. Yard-and stay jury rig.

b. For discharging operations, rigging is accomplished as follows:

(1) The cargo runner on the outboard boom is removed and replaced by a manila line $3\frac{1}{2}$ or 4 inches in circumference. This line is married to the regular runner on the amidship boom.

(2) The booms are spotted as for regular yard-and-stay operation.

(3) The regular wire runner on the amidship boom is made fast to the operating winch. The manila line acting as the Burton fall is led to the cathead of the inoperative winch.

c. Operating procedure for this rig is as follows:

(1) The draft is hoisted out of the hatch on the hatch fall to a point sufficiently high to permit it to swing in an arc and clear the rail, using the distance from the headblock on the outboard boom to the hook as a radius (A, fig 3-42).

(2) The outboard fall is hauled handtight and held with three turns around the cathead to hold

the entire weight of the draft when the up-and-down fall is slacked off, allowing the draft to swing into position under the headblock of the outboard boom (B, fig 3-42).

(3) The draft is then in position to be lowered directly to the dock or conveyance by surging off (slacking off) the outboard fall on the cathead.

(4) Care must be exercised that the draft is landed properly the first time since power is not readily available to raise it.

d. Blocks used in connection with the rope Burton fall should have a rope-scored sheave for use in this operation.

e. This expedient can be rigged so that the power of the one operating winch can be applied to both falls (fig 3-43), but this should only be attempted with experienced personnel. The man handling the outboard fall (sometimes referred to as the Burton man) must be highly skilled in handling lines. Rigging and operation are accomplished as follows:

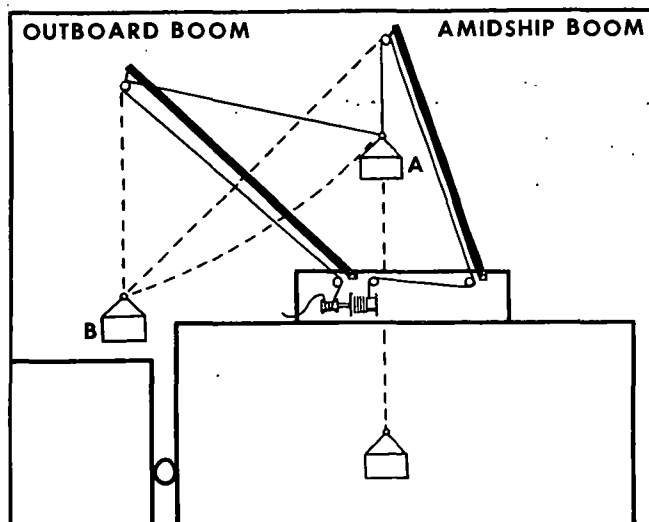


Figure 3-43. Yard-and-stay jury rig with power.

(1) The wire cargo runner of the hatchboom is made fast to the working winch in the same manner as in the method described above; however, the manila cargo runner of the outboard boom is lead to the cathead of the working winch.

(2) When the load is hooked up and ready to be lifted, the Burton man takes one turn around the cathead with the manila cargo runner in the same direction as the turns of the cargo runner on the drum of the winch.

(3) As the load is hoisted, the Burton man hauls away on the manila fall, thus keeping the slack out of the fall. When the load is at the required height above the hatch coaming (A, fig 3-43), the manila fall is quickly removed from the cathead, and three turns are taken on the cathead in the opposite direction to the turns of the cargo runner on the drum of the winch.

(4) As the winch operator slacks off on the wire hatch runner, the Burton man hauls in on the manila outboard fall. This action moves (Burtons) the load across the fall. When the wire fall is slack, the manila line will have the weight of the load. The load is lowered to the pier by surging off the manila fall on the cathead (B, fig 3-43). If it is necessary to raise the load after it has been landed, the wire fall can be slacked a little more and the manila fall hauled in at the same time.

(5) By surging off or hauling in the manila fall as required, an experienced Burton man can control the movement of the draft.

3-38. Expedients for Replacing Winch Power

a. When one winch is disabled, it is often possible to fairlead the cargo runner through snatch blocks to the winch at an adjacent hatch rather than rig the yard-and-stay jury rig.

b. If there is room for maneuvering, a truck may be used to replace the power of a disabled winch by fairleading the cargo runner to the pier and making it fast to the truck as illustrated in figure 3-44.

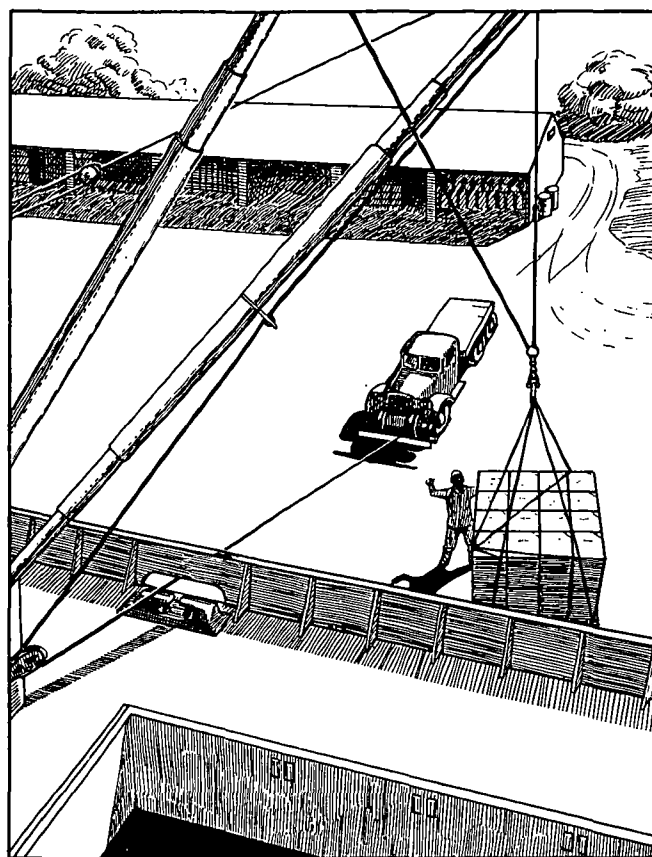


Figure 3-44. Replacing damaged winch with truck on wharf.

3-39. Single Swinging Boom With Offcenter Block (fig 3-45)

a. If one boom becomes damaged and it is not possible to physically replace the boom or to marry the operating boom to a boom at an adjacent hatch, the single swinging boom (para 3-18) can be used as an expedient for loading or discharging a hatch. An offcenter block used with the single swinging boom will speed up the operation considerably and reduce the sources of power required.

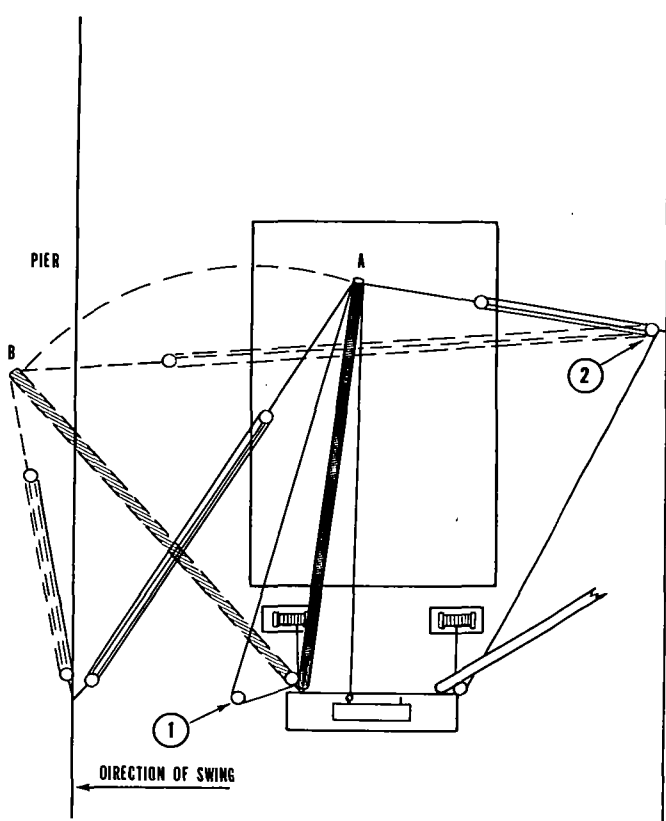


Figure 3-45. Single swinging boom with an offcenter block.

b. Rigging a single swinging boom with an offcenter block is accomplished as follows:

(1) The topping lift is rigged and made fast as described in paragraph 3-18.

(2) The offcenter block (snatch block) is placed on the deck in line with and approximately 4 feet from the heelblock in the direction in which the load is to be swung (1, fig 3-45). Some experimentation may be necessary to determine its exact location.

(3) The cargo runner is made fast to the winch and reeved through the heelblock, the offcenter block, and the headblock.

(4) The inboard guy is led at right angles to the boom when plumbed over the hatch (2, fig 3-45). This guy must be long enough to allow the boom to swing out over the pier from position A to position B. The hauling part of the inboard guy is led to the offshore winch.

(5) After the load has been hoisted high enough to clear the hatch coaming and the rail, the stress on the fall leading to the offcenter block pulls the boom outboard, and the boom slews outboard as the inboard guy is slacked off.

(6) The slack of the outboard guy should be taken in by hand. When the load has been landed on the pier, the boom can be swung inboard by power on the inboard guy.

Section IX. DEVELOPMENTS IN SHIP'S GEAR

3-40. Farrel Rig (fig 3-46 and 3-47)

a. A major improvement in the yard-and-stay method of rigging the ship's gear for Burtoning cargo was made in 1947. This method consists of placing the heels of the outboard guys or vangs on a common axis or making them coaxial. Topping-lift winches are installed and the hauling part of the topping lift is reeved through lead blocks secured near the ship's centerline.

b. Once the guys have been secured to the short vang posts and pulled tight, there is no need to tend guys. The boomhead moves vertically along a straight line parallel to the centerline of the ship. With this setup, all that must be done to top or lower the boom is to press the button controlling the topping-lift winch.

c. The addition of vang winches makes this rig more useful. With the guys led to power, it is possible to swing the boom in either direction under power, thus providing complete power positioning of the unloaded boom.

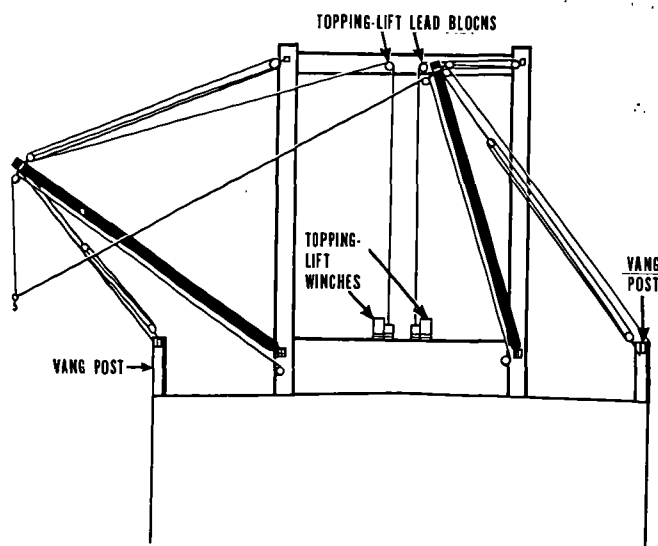


Figure 3-46. Elevated view of the Farrel rig.

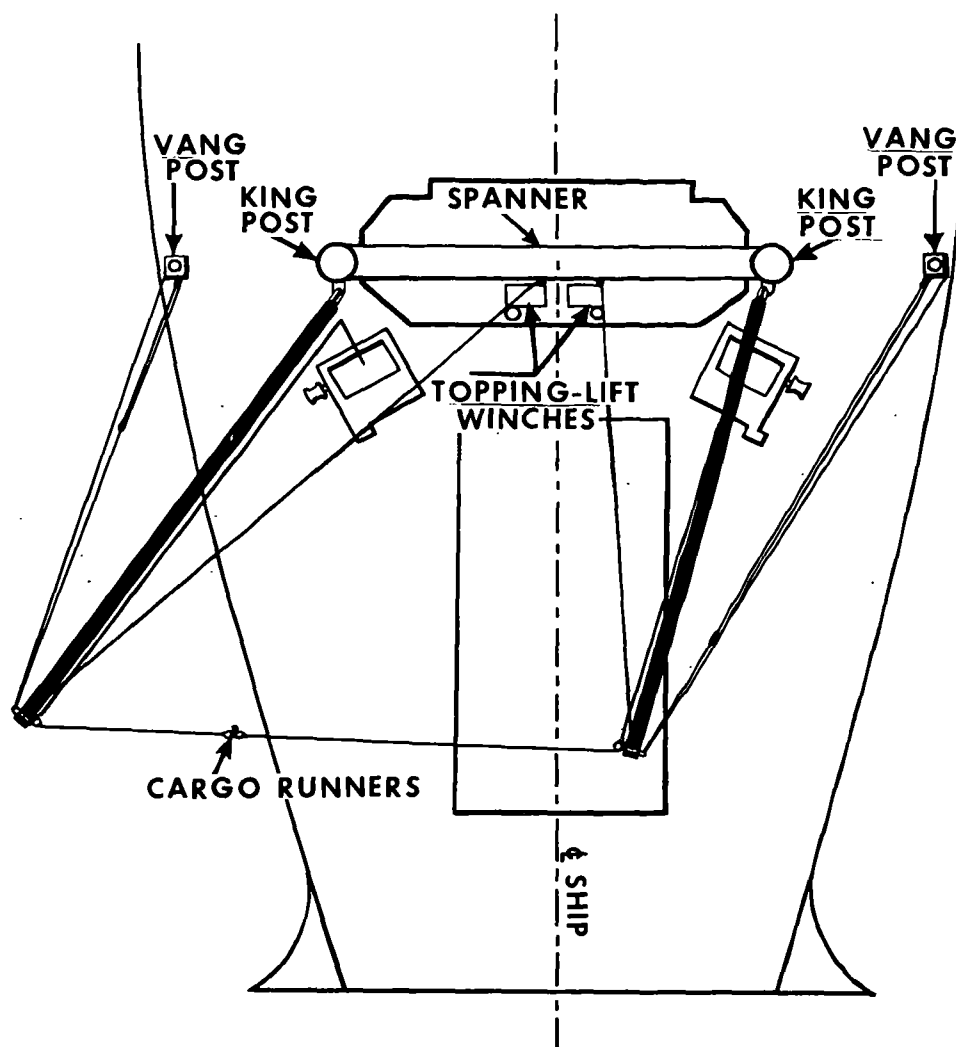


Figure 3-47. Plan view of the Farrel rig.

3-41. Ebel Rig

- a. The Ebel rig was designed to—
- (1) Handle loads up to the full capacity of 5- and 10-ton booms by the Burton system.
 - (2) Provide for complete power positioning of the unloaded booms.
 - (3) Eliminate manual handling of lines.
 - (4) Increase safety.

b. Figure 3-48 shows schematically the arrangement of the topping lift on the 5- and 10-ton booms. The topping lift is offset inboard near the centerline of the ship to control the swinging of the boom in the outboard direction. The hauling part of the topping lift is led down the inboard side of the king post through a leadblock to the drum of one of the topping-lift winches mounted on the king post.

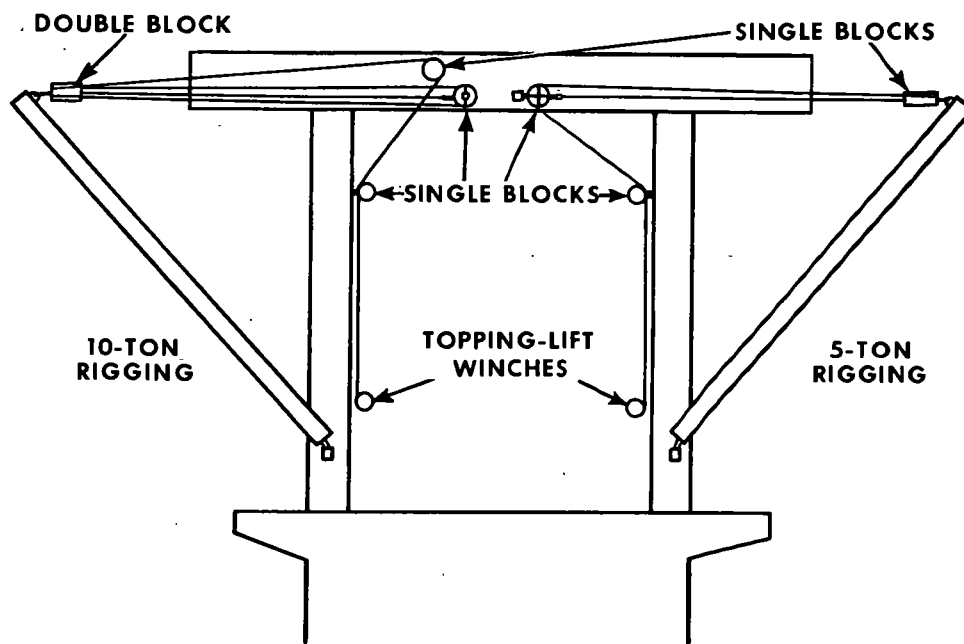


Figure 3-48. Arrangement of the topping lift with the Ebel rig.

c. Figure 3-49 illustrates the arrangement of the mechanical guys on the 5- and 10-ton booms. When rigging the 5-ton boom, the standing part of the guy is secured to the extreme outboard end of the crosstree and run over a sheave at the head of the boom, down to a sheave at the bulwark,

back around the second sheave at the head of the boom, through a leadblock, and then down the outboard side of the king post to the drum of the electric guy winch mounted on the king post. No vang posts are necessary because the guy is made fast to the deck or bulwark.

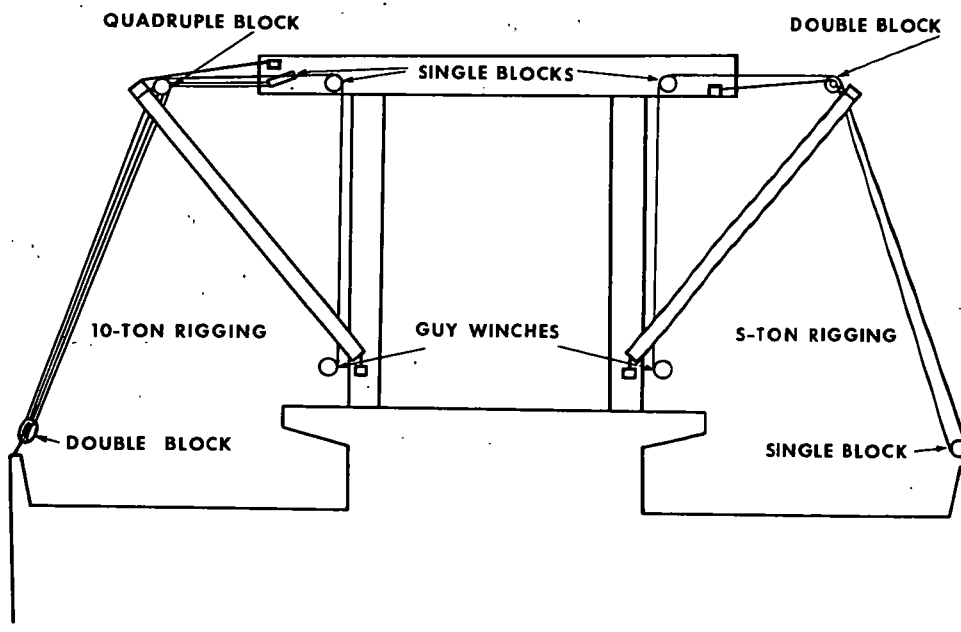


Figure 3-49. Arrangement of the mechanical guys with the Ebel rig.

d. The Ebel rig is designed so that the effective guy resultant force keeps the stresses moderate, even when 5- and 10-ton loads are being handled. If the draft is hoisted to excessive heights, the

outboard boom head will rise by riding up the bight of the guy tackle until it reaches a position of equilibrium with the load. While the boom head rises, the draft remains almost stationary. The

angle between the two falls is thus limited to a fixed predetermined maximum, and no part can be overloaded. When the draft is lowered by slacking off on the falls, the boom resumes its normal position by riding down the bight of the guy. Since the boom is never free from the tensioned guy, it cannot drop freely. When moving (Burtoning) 5 tons, the minimum height of the married fall above the deck at which the outboard boom will ride up is about 30 feet; for lighter loads, it is higher. The draft is ample to handle almost any draft.

3-42. Cranes Aboard Ship for Cargo Handling

a. During recent years the military services and commercial steamship companies have been using shipboard cranes to replace the yard-and-stay rig in some instances. Since the crane

operators are part of the ship's crew, military personnel would not normally be required to operate these cranes.

b. There are three principal types of cranes which military stevedores might be called upon to operate:

(1) A crane mounted on the centerline of the vessel between two hatches and capable of working the ends of both hatches or a combination of crews working one or more hatches (fig 2-13).

(2) An overhead crane mounted on trucks which run forward and aft paralleling the centerline of the ship. The crane extends over the side of the vessel. When the draft is hoisted to the desired height, it can be moved athwartship on a beam-type trolley. One type of overhead crane is illustrated in figure 3-50.

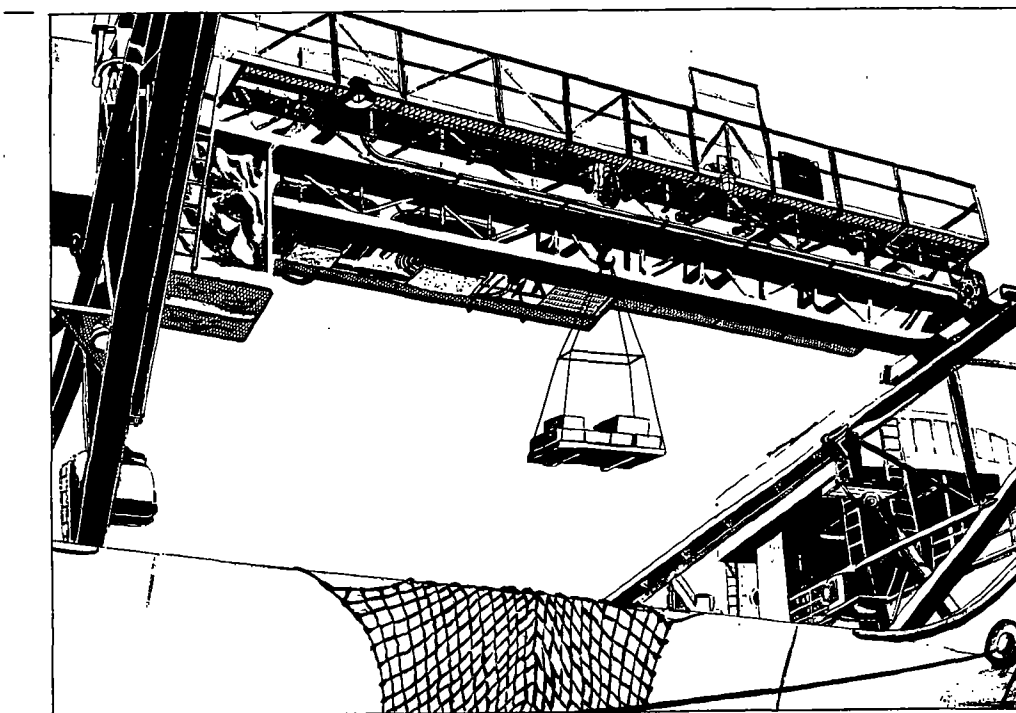


Figure 3-50. Overhead crane.

(3) A side port crane mounted to the overhead of the 'tween decks. The crane boom can be extended over the pier. The draft which is

hooked up by means of short bridles is hoisted to the height of the side port opening and then across the vessel by a trolley (fig 3-51).

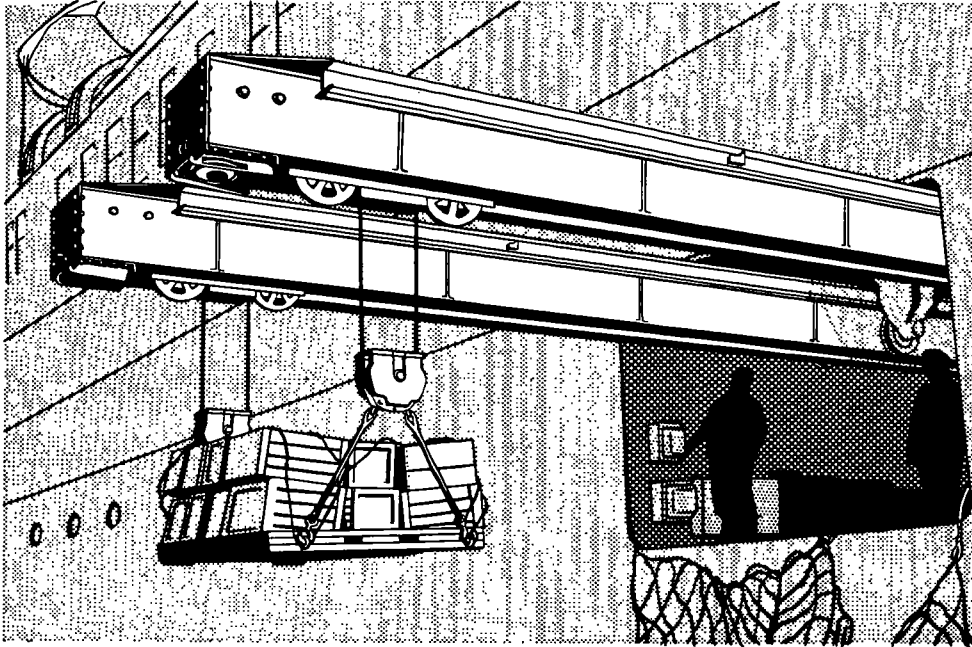


Figure 3-51. Side port crane.

CHAPTER 4

CARGO HANDLING GEAR

4-1. Classification

The cargo handling gear used in conjunction with the ship's gear to load or discharge cargo may be divided into three classes:

- a. All-purpose gear which can be used for many types of cargo.
- b. Special purpose gear which is designed for use on one type of cargo.
- c. Cargo handling aids which are provided to assist the individual longshoreman in handling cargo.

4-2. Selection of Cargo Handling Gear

Proper use of cargo hoisting or cargo handling

gear is essential to safe and efficient cargo operations. Personnel may use the wrong kind of gear simply because the correct gear is not handy. This can be overcome by conscientious training and supervision. After the gear has been selected, it must be checked for defects and replaced or repaired if necessary.

4-3. Endless and Single Slings

- a. An endless sling (fig 4-1 and 4-2) is made by splicing the ends of a piece of wire or fiber rope together. It is simple to handle and may be used in several different ways to lift loads. The endless sling is most commonly used as a choker sling.

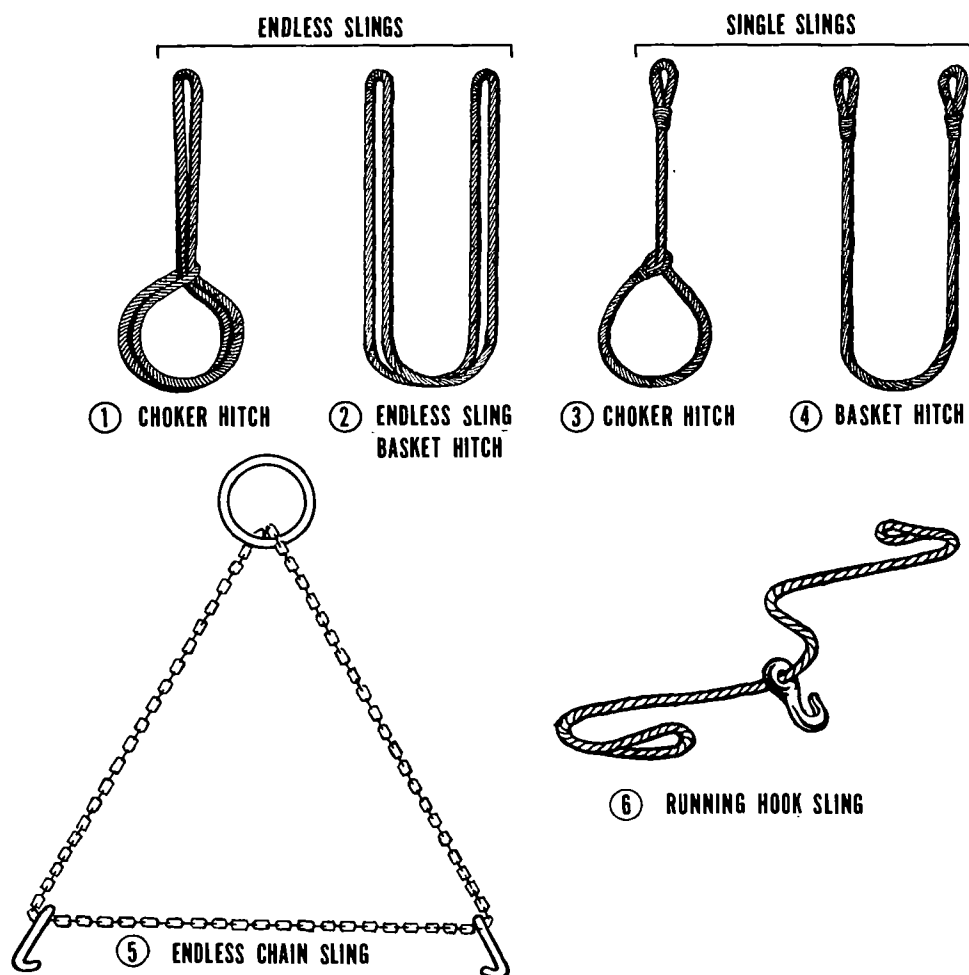


Figure 4-1. Endless and single slings.

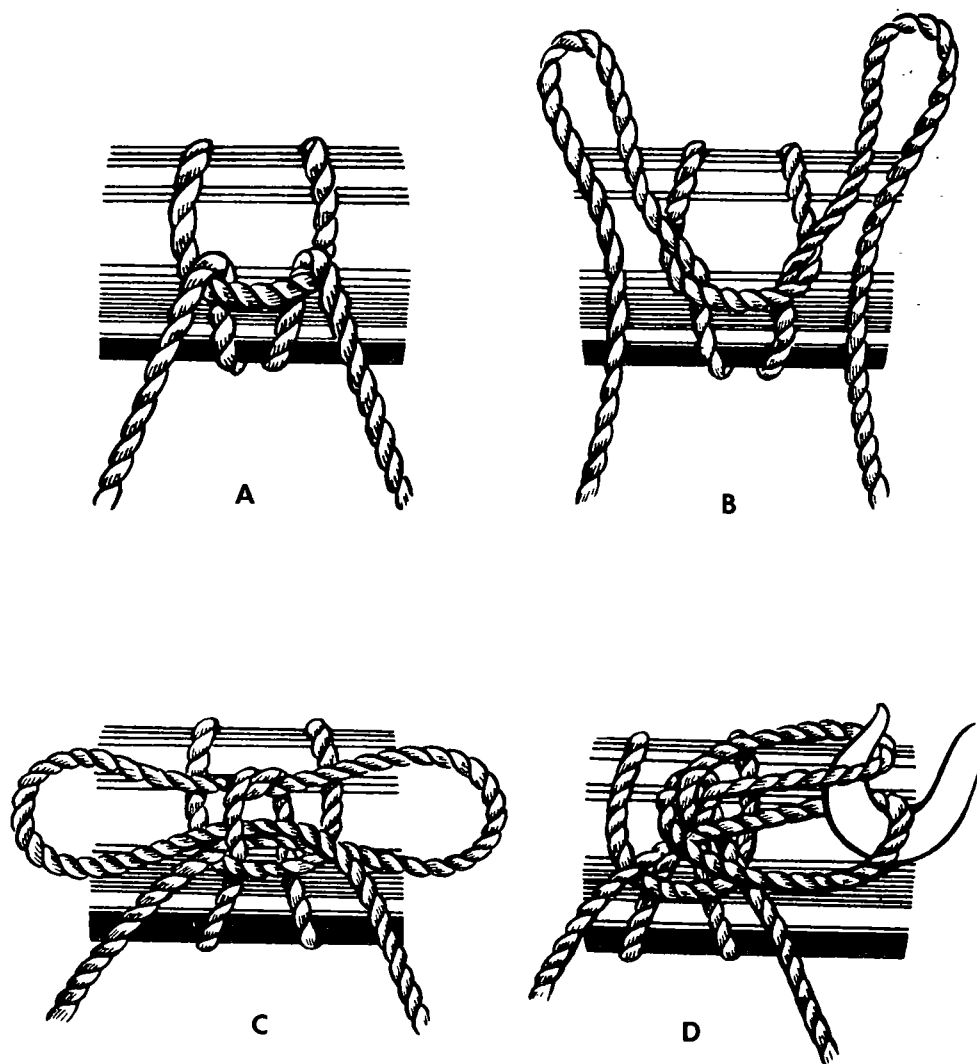


Figure 4-2. Sling shorteners.

(1) The endless sling when used as a choker (1, fig 4-1 and A, fig 4-2) is passed around the draft of cargo so that one end forms a loop on top of the draft. The other end is passed through this loop, pulled tight, and attached to the cargo hook.

(2) To balance the load, the two parts of the sling on the bottom of the draft are spread apart. If necessary, the sling may be shortened by making two bights in the long end of the line (B, fig 4-2) and tying an overhand knot (C, fig 4-2). The two loops are then placed on the cargo hook (D, fig 4-2).

b. The endless sling may also be used with chime or running hooks (5 and 6, fig 4-1). It may be used as a basket sling, an inverted basket, or a vertical sling. However, in almost every case where an endless sling can be used, better results are obtained by using a single sling or a com-

bination of single slings to do the job. The endless sling is being replaced by more specialized gear.

c. A single sling (fig 4-1) is made of fiber or wire rope. Each end of the single sling is made up with an eye, a hook, a ring, or a thimble, depending upon the intended use of the sling. A single sling can be used as a vertical sling, a basket sling, or as a choker sling with a choker hitch.

d. Single slings made of fiber rope are used for light loads and for cargo that might be damaged by wire slings. Wire rope slings have a variety of uses and are made up in lengths ranging from 5 to 150 feet, or even longer for special cargo.

4-4. Combination Slings

a. Two or more single slings can be combined by shackles, hooks, rings, or chains to pick up almost any type of cargo. If greater length is

required, two single slings can be shackled together.

b. Single slings can be combined into bridle

slings, basket slings, and choker slings. They may be used as two-legged or four-legged slings.

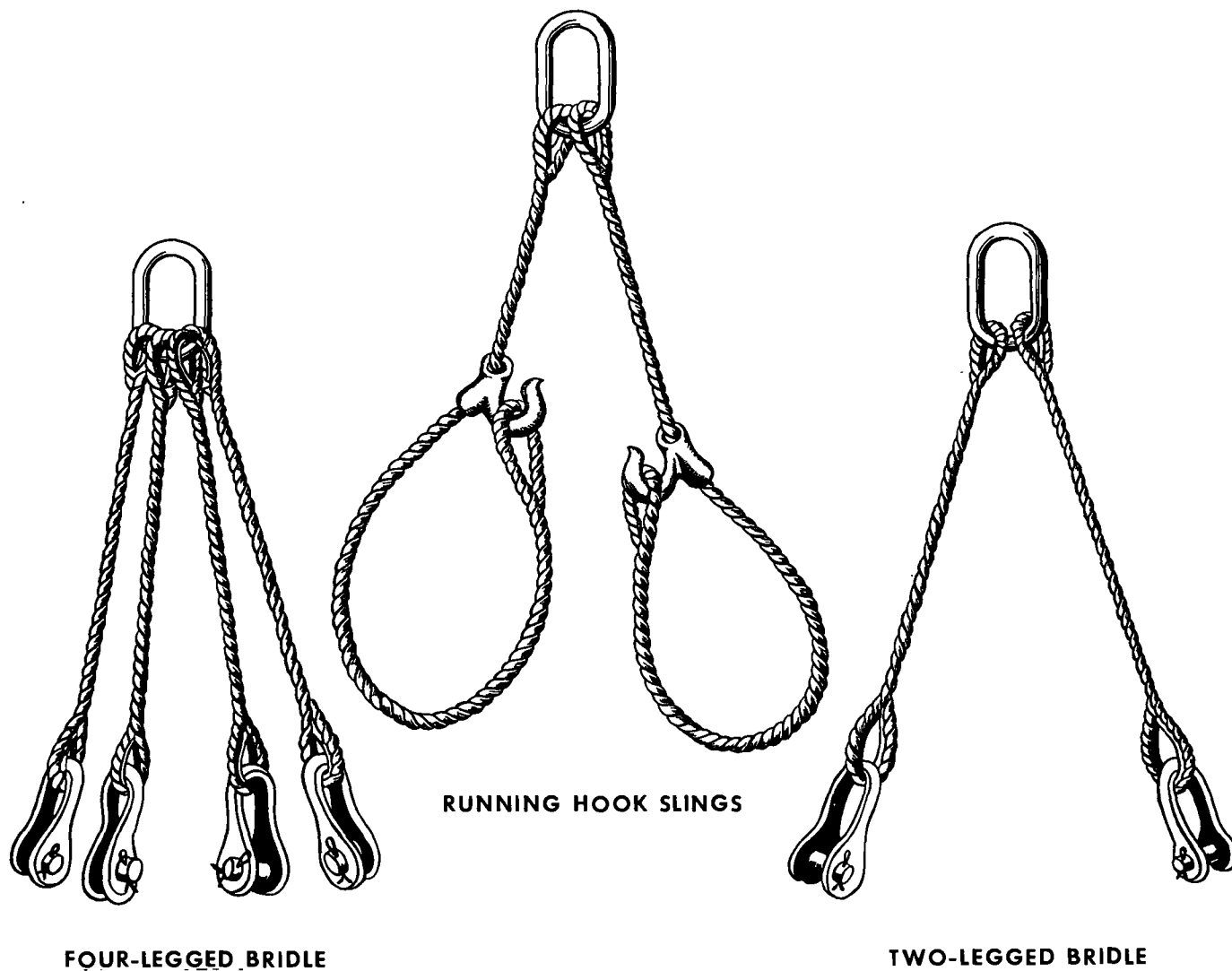


Figure 4-3. Combination slings.

c. Tables 4-1 and 4-2 illustrate the safe working loads of slings of wire and manila rope at various angles.

Table 4-1. Safe Load in Pounds Under Different Loading Conditions for Slings of New Improved 6x19 Plow-Steel Wire Rope

Diameter (inches)	Single wire-rope sling, vertical lift	Sling or two wire ropes used at 60° angle	Sling or two wire ropes used at 45° angle	Sling or two wire ropes used at 30° angle
1/2	4,320	7,475	6,105	4,320
5/8	6,650	11,500	9,400	6,650
3/4	9,480	16,400	13,400	9,480
7/8	12,900	22,350	18,250	12,900
1	16,800	29,100	23,750	16,800
1 1/8	21,200	36,700	30,000	21,200
1 1/4	26,000	45,000	36,800	26,000
1 3/8	32,000	55,400	45,250	32,000
1 1/2	37,000	64,000	52,340	37,000
1 3/4	49,800	86,250	70,500	49,800

Table 4-2. Safe Load in Pounds for Slings of New Standard Three-Strand Manila Rope With a Splice in Each End

Circumference (inches)	Diameter (inches)	Single rope sling, vertical lift	Double rope sling used at 60° angle	Double rope sling used at 45° angle	Double rope sling used at 30° angle
2 1/4	3/4	970	1,680	1,375	970
3	1	1,620	2,805	2,290	1,620
3 1/2	1 1/8	2,160	3,740	3,060	2,160
3 3/4	1 1/4	2,430	4,205	3,437	2,430
4 1/2	1 1/2	3,330	5,770	4,715	3,330

d. When hoisting cargo with slings, angles of less than 45° from the horizontal should be avoided.

4-5. Chain Slings

a. Chains made of standard links must not be subjected to loads greater than those shown in

table 4-3. A chain which shows evidence of having been stretched should not be used for lifting. Stretching is evidenced by small cracks in the links, binding between links, or signs of elongation in the links.

Table 4-3. Safe Load in Pounds of New Wrought-Iron Chain Slings

Diameter of link stock (inches)	Single sling, vertical lift	Sling or two chains used at 60° angle	Sling or two chains used at 45° angle	Sling or two chains used at 30° angle
3/8	2,510	4,350	3,555	2,510
1/2	4,180	7,250	5,915	4,180
5/8	6,460	11,175	9,150	6,460
3/4	9,160	15,850	12,950	9,160
1	17,300	29,900	24,450	17,300

b. When a chain sling is used for handling steel items such as rails, pipe, beams, and angles, a turn should be made around the draft and the hook placed around the chain. Dunnage should always be used between the chain and the draft to provide a complete bearing surface.

4-6. Canvas Slings

A canvas sling is a rope sling with a section of canvas sewn between the ropes. The main type of canvas sling now in use is the dirt sling. Dirt slings (fig 4-4) are used to hoist the sweepings out of a hatch after cleaning. In commercial practice, canvas slings similar to dirt slings are used for handling cargo such as nitrate.

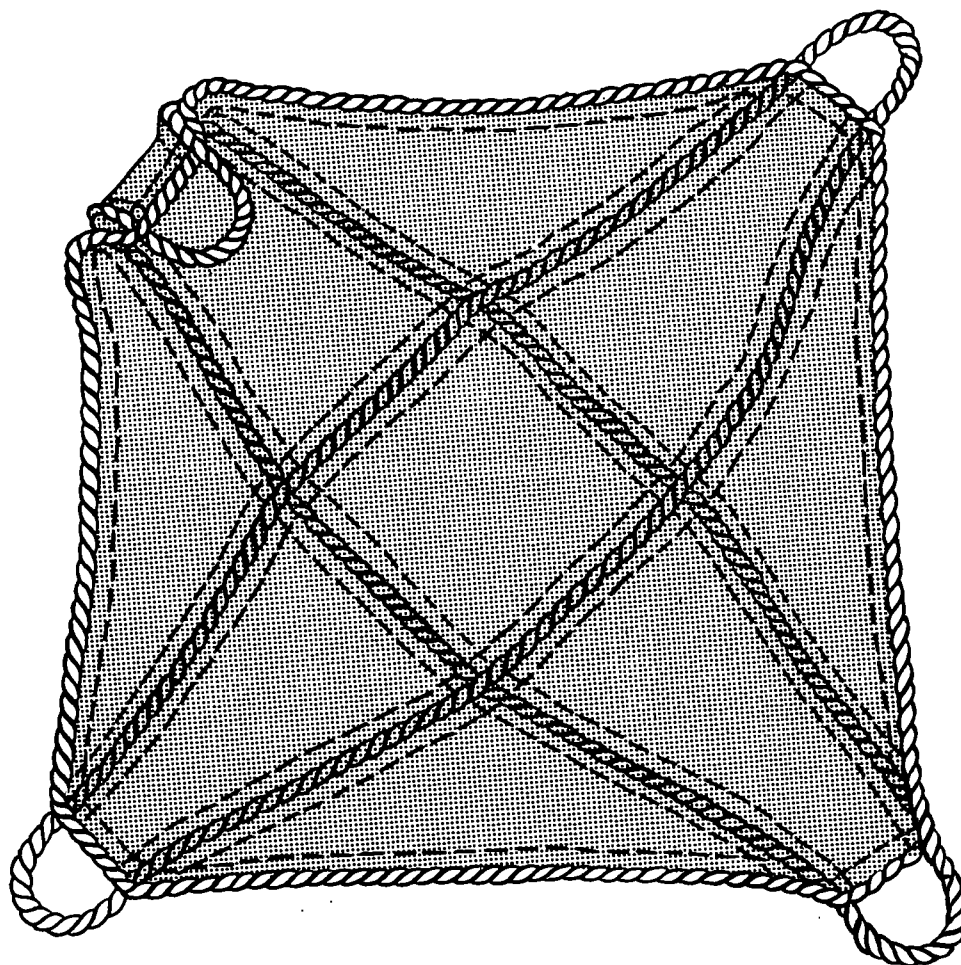


Figure 4-4. Dirt sling.

4-7. Cargo Nets and Pie Plates

a. Cargo nets are usually made of manila rope, but nets of wire rope are used for special cargoes. The standard Army cargo net is 14 by 14 feet with a 7-7/8-inch square mesh. The square meshes are made of 2½-inch-circumference manila rope, and the jackstay is made of 3-inch-circumference manila rope.

b. Cargo nets may be used to handle packages that are not uniform in size. The packages must be strong enough to withstand pressure. When making up a draft in a cargo net, the cargo should be stacked so that the crushing effect of the net is kept to a minimum. The practice of throwing cargo into the net, placing the bridle on the cargo hook, and crushing the cargo together as the draft is hoisted should be prohibited.

c. The crushing effect of the cargo net can be reduced by the use of a pie plate (fig 4-5) which permits fragile cargo to be handled. The pie plate is placed in the center of the net and the cargo stacked so that all the pressure is on the pie plate.

Pie plates may be constructed of two layers of dunnage. They may vary from 54 to 72 inches in diameter.

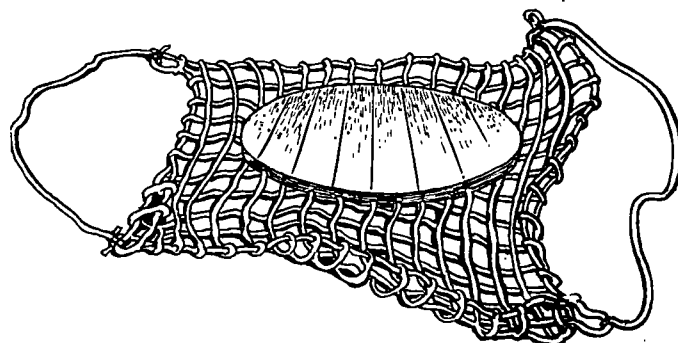


Figure 4-5. Cargo net and pie plate.

d. If pie plates are not available, cargo boards can be used to reduce the crushing pressure of the cargo net. Cargo boards may be constructed of two layers of dunnage nailed together to make a

solid board 4 by 6 feet. The cargo board is placed in the center of the net and is used in the same manner as a pie plate.

4-8. Pallets

a. The four basic types of pallets used in military cargo handling are the stevedore, general purpose, sled, and warehouse pallets.

(1) The stevedore pallet (fig 4-6) is used to handle cargo at water terminals. Because of the rough treatment the stevedore pallet receives, it is made of stronger and more durable materials

than the general purpose or the warehouse pallet. The standard stevedore pallet is 4 feet wide, 6 feet long, and 8 inches high. The stringers are made of 3- by 4- or 4-inch lumber, and the deck boards are made of 2-inch-thick lumber. The outside or end boards should not be less than 6 inches wide; the inside boards may be random widths. The stevedore pallet is reversible. The outside stringers are set in 4 to 6 inches from the ends so that a pallet bridle may be inserted. The inside stringers are arranged to permit easy entrance of forks for movement by forklift trucks.



Figure 4-6. Stevedore pallet.

(2) The general purpose pallet (fig 4-7) is a four-way entry wood pallet 48 inches long, 40 inches wide, and approximately 5¼ inches high.

It is used extensively for the shipment of palletized cargo. It often accompanies the cargo from shipper to consignee.

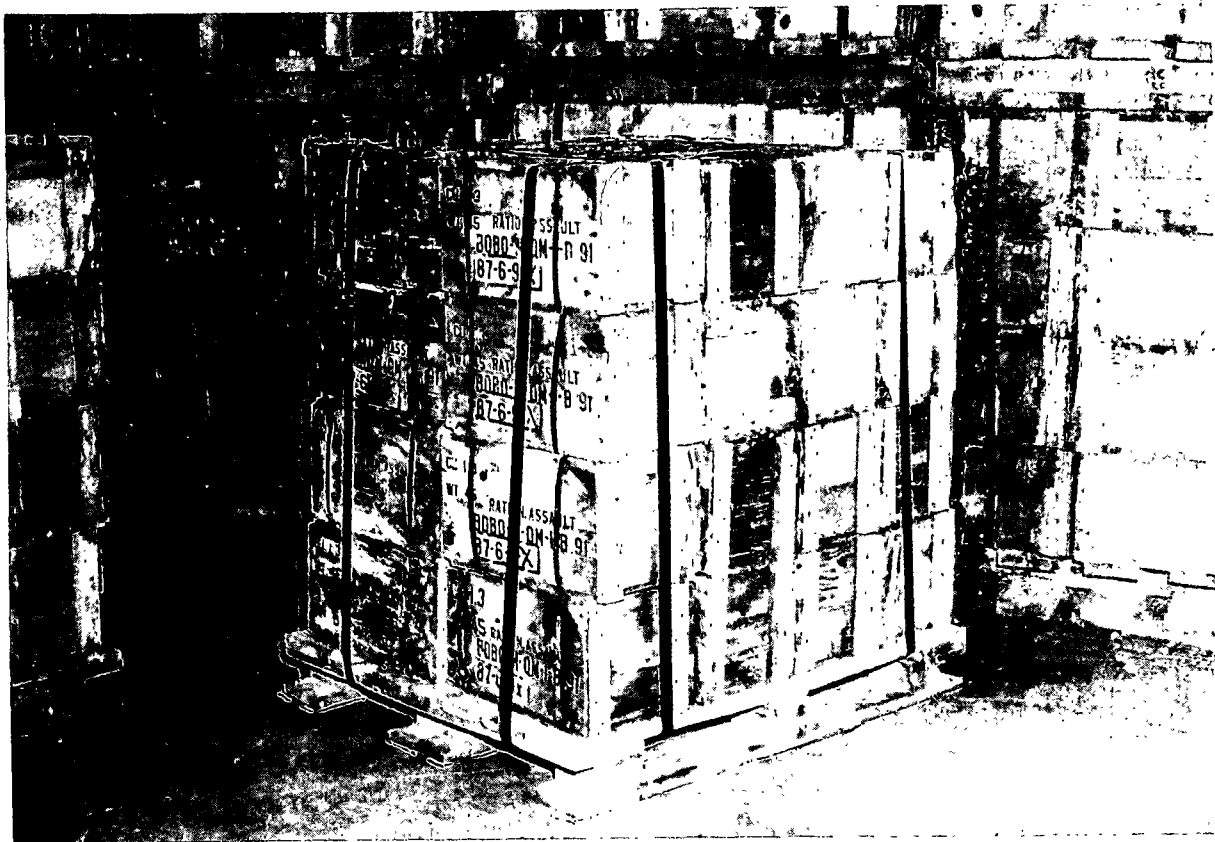


Figure 4-7. General purpose pallet.

(3) The sled pallet (fig 4-8) consists of a heavy timbered platform with runners. Supplies and equipment are normally bonded to the pallet. The standard size for this sled pallet is 6 by 4 feet. The platform, or deck, is made of 2-inch-thick lumber, and the runners are 6-foot lengths of 4-

by 6-inch lumber. Sled pallets are designed for towing. The sled pallet commonly is used in amphibious operations where it may be handled, floated, or dragged over the beach to beach and inland dumps.

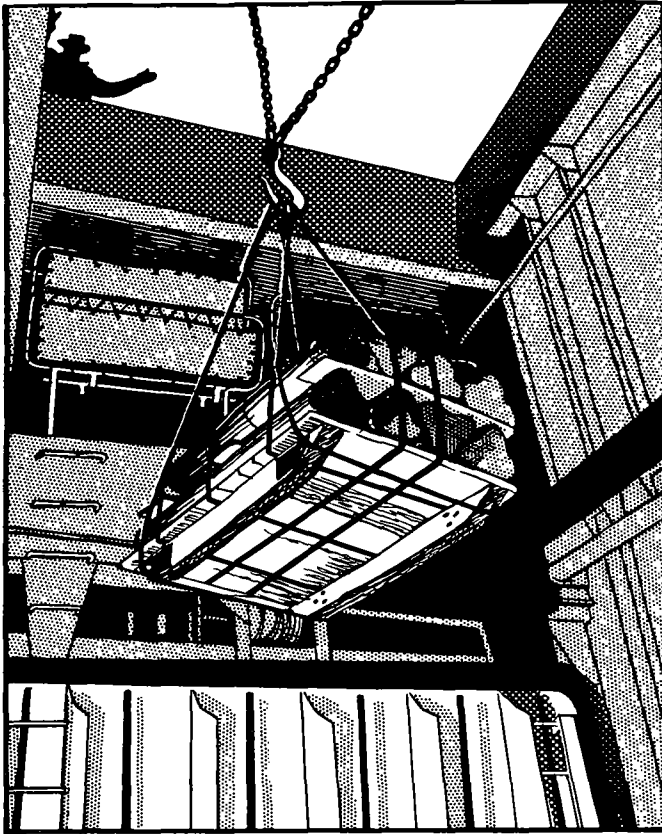


Figure 4-8. Sled pallet

(4) The warehouse pallet is used to handle cargo in warehouses. It is much lighter than the stevedore pallet. The most common size of warehouse pallet is 48 by 48 inches, but a 40- by 48-inch size is also made. The warehouse pallet can be the open end type that can be moved by a forklift or hoisted by a pallet bridle or the closed end type that can be moved by forklift only.

b. When items of cargo are palletized, the tiers should be laid in such a manner that one tier ties together with another to give stability to the unitized load and to keep the cargo from falling off the pallet while it is being moved from one place to another. Greater use of the pallet area can be obtained by building the load in a definite pattern whenever possible.

4-9. Spreaders

Some of the most common types of spreaders are listed below.

a. The vehicle spreader (fig 4-9) is made of lengths of hardwood, pipe, or steel beams. It permits a straight pull on the sling and wheel nets, thus keeping pressure away from the sides of the vehicle. The size of the spreader depends on the type of vehicle to be hoisted.

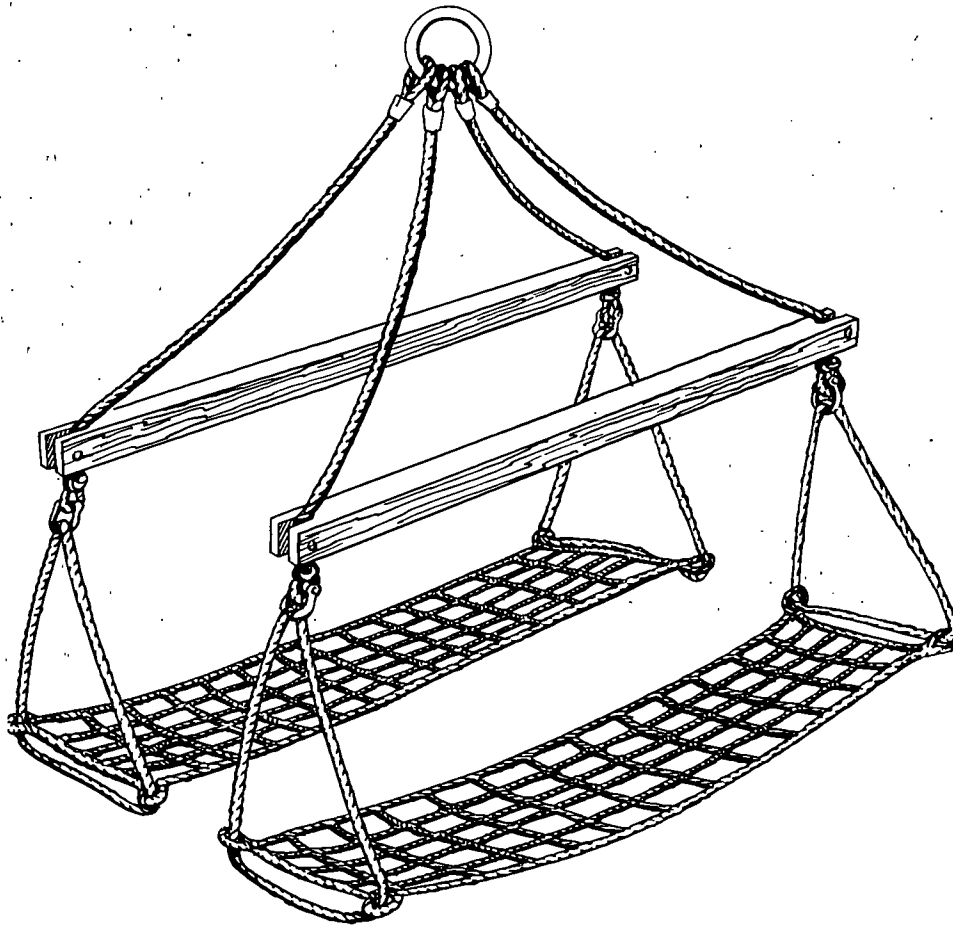


Figure 4-9. Vehicle spreaders with wheel nets.

b. The heavy lift spreader (fig 4-10) is made of steel beams, because stronger material is required

to keep greater pressure away from the side of the heavy lift.

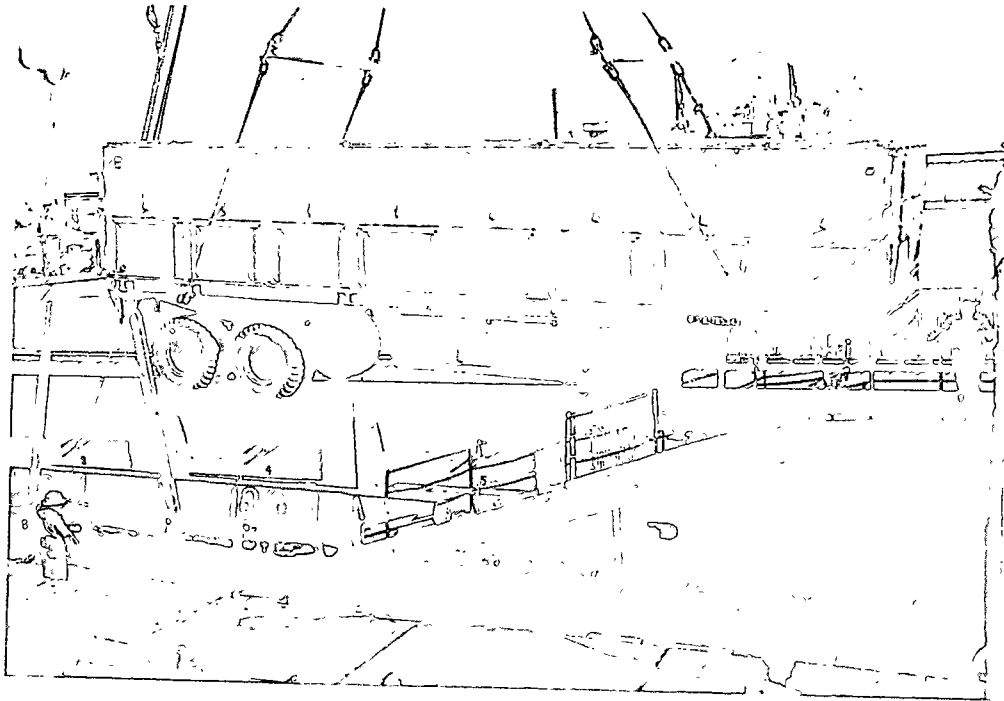


Figure 4-10. Heavy lift spreader.

c. Barrel sling spreaders (fig 4-11) may be triangular, straight, or square. They are usually made of plate steel with holes for the shackles which hold the chime hooks. Hoisting a number of drums at one time is made possible with the use of the barrel sling spreader.

d. Pallet bridle spreaders keep pressure away from the sides of the draft. The square type (A, fig 4-12) is made of steel, and the straight type (B, fig 4-12) is made of steel or hardwood.

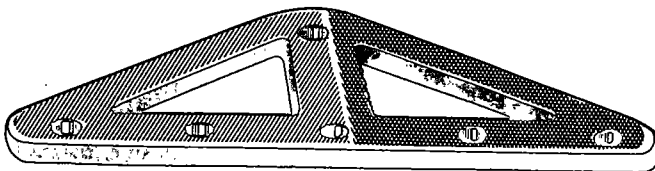


Figure 4-11. Barrel sling spreader.

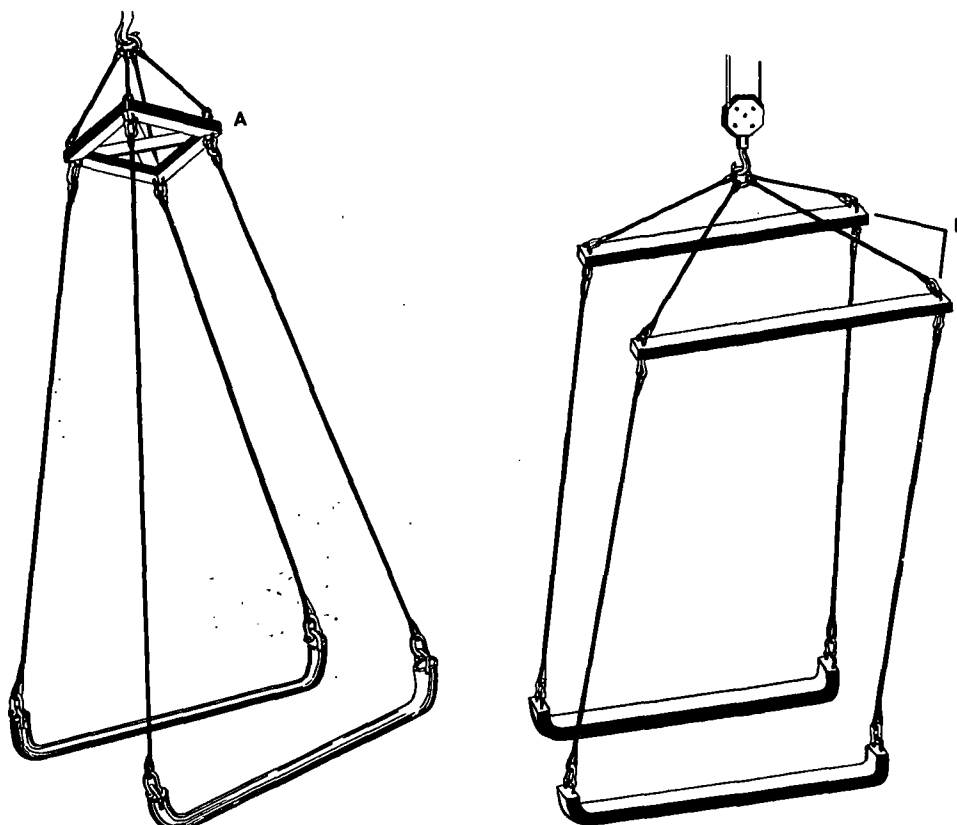


Figure 4-12. Pallet bridle spreaders.

4-10. Bridles

a. Bridles are usually made to handle a special type of lift. Listed below are the most common types of bridles.

(1) Pallet bridles (fig 4-12) are used for quick, efficient handling of palletized cargo.

(2) Beam bridles (fig 4-13) are designed to remove hatch beams from their sockets. The hooks are placed on opposite sides of the beam in the lightening holes or rings as provided. The beam will then ride level and straight up and down. Tag lines should be attached to the bridles for control and safety.

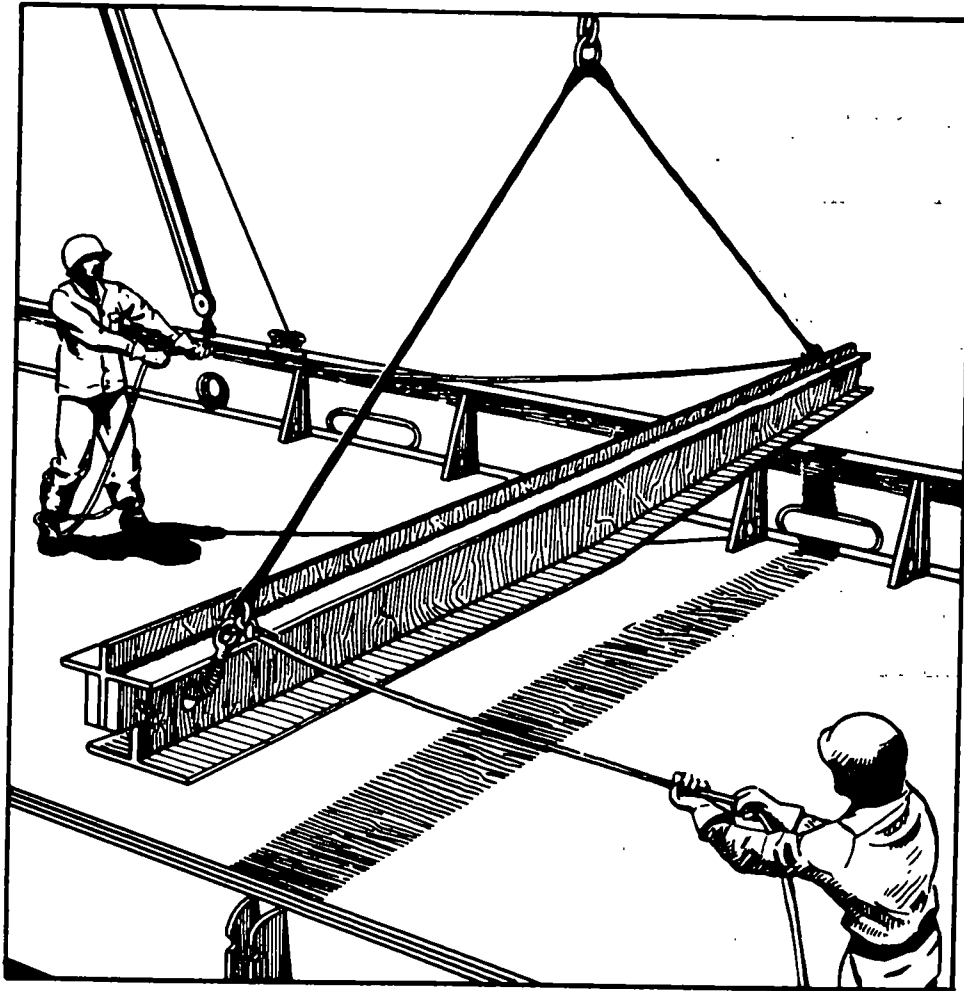


Figure 4-13. Beam bridle.

(3) Vehicle bridles are designed for efficient handling of various types of vehicles. The size of the bridle depends on the size of the vehicles to be hoisted. Figure 4-9 illustrates a type of bridle used on sedans and privately owned vehicles. Figure 4-10 shows a heavy-duty vehicle bridle for use on trucks.

(4) Heavy-duty bridles are designed to reduce side pressure on heavy lifts.

b. Chime hooks are usually combined with

spreaders to make bridles which will increase the number of drums that can be hoisted at one time (fig 4-11).

c. Bridles employ a combination of wire rope, shackles, hooks, rings, and chain. It is important that terminal service personnel using bridles be familiar with the safe working load of this type of gear. Table 4-4 gives the recommended minimum size of shackles, chain, hooks, and rings to be used with various sizes of wire rope.

Table 4-4. Recommended Minimum Sizes of Gear to be Used With Various Sizes of Wire Rope

Improved plow-steel 6x19 wire rope (hemp center)		New wrought- iron chain (diameter of stock in inches)	Round-pin or screw-pin shackle (diameter of pin in inches)		Drop-forged steel hooks (diameter in inches)		Steel rings and links (diameter of stock in inches)		
Diameter in inches	Safe load (pounds)		Screw pin	Round pin	Eye	Throat	Circle	Oblong	Triangle
1/2	4,300	1/2	3/4	5/8	1 1/4	1 3/8	1	9/16	3/4
9/16	5,400	9/16	3/4	3/4	1 3/8	1 1/2	1 1/4	5/8	7/8
5/8	6,600	5/8	7/8	3/4	1 1/2	1 3/4	1 1/4	3/4	7/8
3/4	9,400	3/4	1	7/8	1 3/4	2	1 1/2	1	1
7/8	12,800	7/8	1 1/8	1	2 3/8	2 1/2	1 3/4	1 1/8	1 1/4
1	16,000	1	1 1/4	1 1/8	2 3/4	3	2	1 1/4	1 1/2
1 1/8	21,200	1 1/8	1 1/2	1 3/8	3 1/8	3 3/8	2 1/4	1 3/8	1 3/4
1 1/4	26,000	1 1/4	1 5/8	1 1/2	3 1/2	4	2 1/4	1 1/2	1 3/4
1 3/8	31,400	1 3/8	1 3/4	1 5/8	3 1/2	4	2 1/2	1 3/4	
1 1/2	37,000	1 1/2	2	2	4	4 1/2	2 3/4	1 3/4	2 1/4

4-11. Wheel Nets (fig 4-14)

Wheel nets are used for hoisting sedans and other light vehicles. The wheel nets included in the cargo vehicles set are 8 by 3 feet with 6-inch mesh. Manila rope 3 inches in circumference is used in the net with the exception of the frame, where 3 1/4-inch manila rope is used.

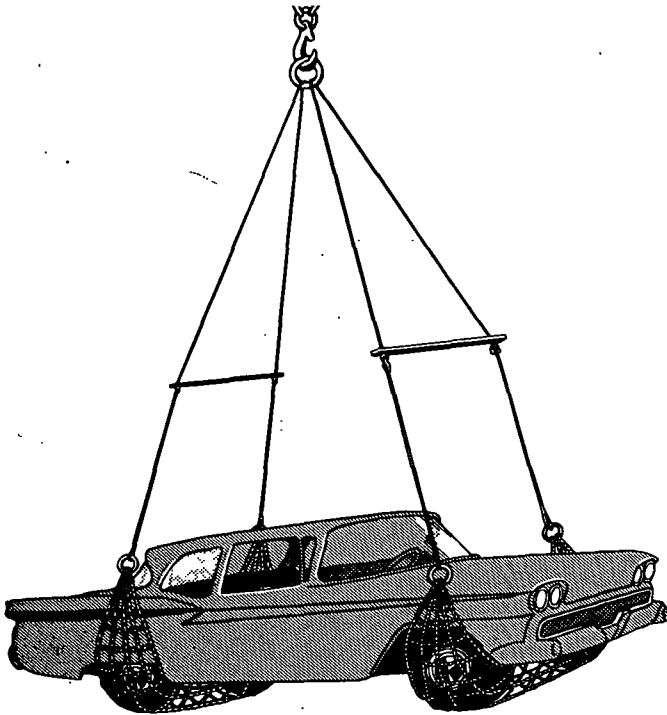


Figure 4-14. Wheel nets.

4-12. Box Hooks

a. A box hook is a heavy steel hook with a studded steel plate on one end and an opening on the other end through which a sling may be passed. Box hooks are used in pairs and are attached to the sling in such a manner that the studded plates are facing each other. When the hooks are positioned on a case or a box and the ends of the sling are placed on the cargo hook, the sling draws the studded plates tightly against the case as it lifts it.

b. Box hooks are designed to lift heavy cases just high enough to permit easy slinging. Cases should never be hoisted or lowered with box hooks only. Box hooks may be used for dragging cases in dragline operations, but they should never be used on fragile cases.

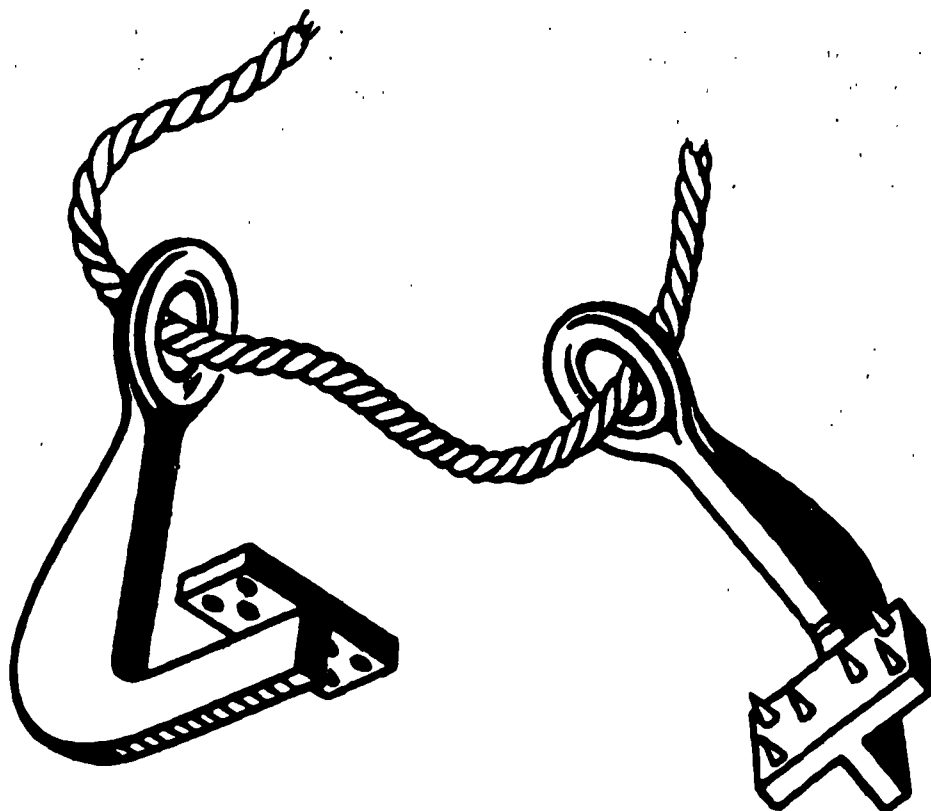


Figure 4-15. Box hooks.

4-13. Chime Hooks

Chime hooks or drums hooks are forged-steel flat hooks with an opening in one end through which a sling may be passed. The hooks are used in pairs and are placed on the sling so that they face each other. The hook end is designed so that it fits the chimes of barrels or drums. The hooks are usually attached to endless chain slings. Several slings are then shackled into a spreader to form a bridle which will accommodate several drums at one time.

4-14. Plate-Handling Clamps

a. Plate-handling clamps are designed exclusively for handling steel plate. The two most common types used in military cargo handling are—

(1) Serrated jaw-type with single lever grip (A, fig 4-16) for lifting plates in a horizontal position.

(2) Serrated jaw-type with double-toothed cam grip (B, fig 4-16). This is chain operated with a sling link for lifting steel plates in a vertical position.

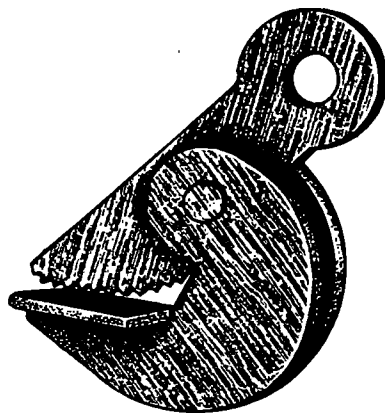
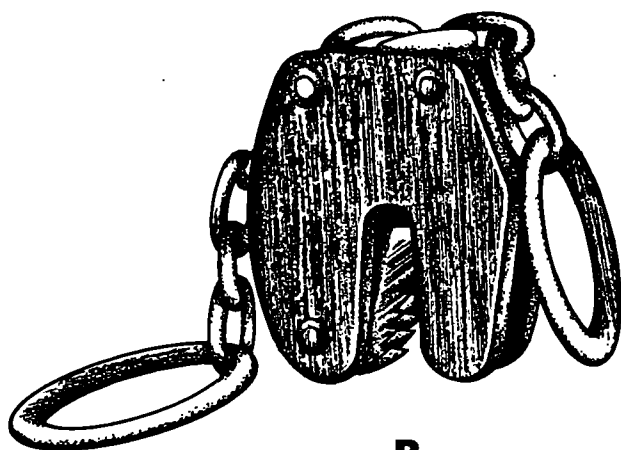
**A****B**

Figure 4-16. Plate-handling clamps.

b. Similar to box hooks, plate-handling clamps are safe for use only when the steel plate is not lifted to a great height. They should be used to lift the plates into position to be properly slung with wire-rope slings. Hoisting steel plates into or out of a hold with clamps may cause a serious accident. Since the clamps release when tension is removed, an unsafe condition could be caused by the plates hitting the coaming or the side of a hatch.

4-15. Rollers (fig 4-17 and 4-18)

Rollers are used to facilitate movement of cargo from the wings and ends of a hatch to or from the square of the hatch. There are several types of rollers usually available.

a. Pallet-type (A, fig 4-17) truck dollies or pallet dollies consist of a steel frame and eight bar rollers. Pallets of cargo may be landed on truck dollies in the square of the hatch. The dollies are then pulled into the wings where the cargo is to be stowed. Empty pallets can be placed on the dollies in the wings. When loaded with cargo, the dollies are pulled into the square of the hatch to be placed in position for hoisting the cargo.

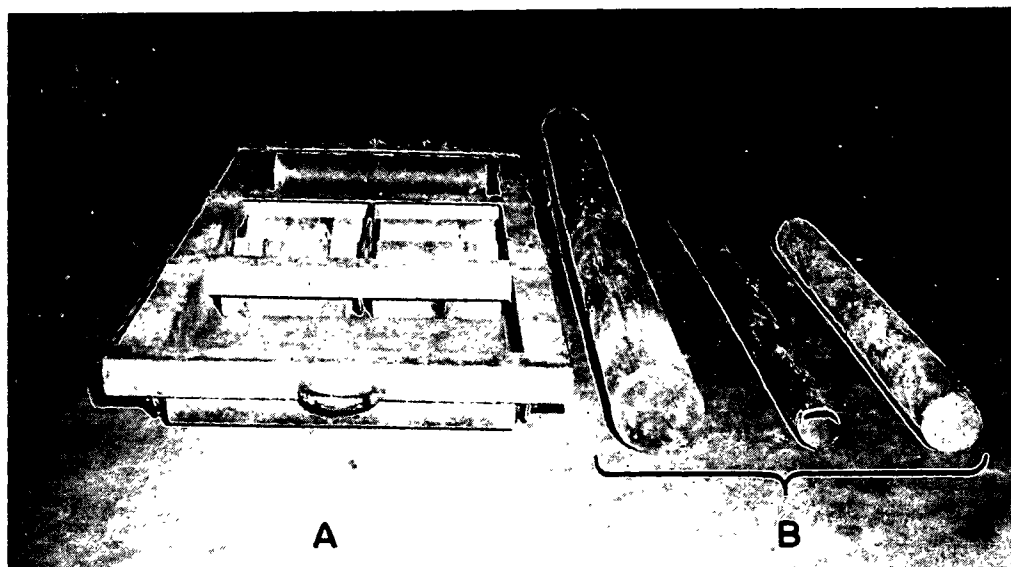
**A****B**

Figure 4-17. Types of rollers.

b. Single rollers (B, fig 4-17) are round bars of wood, steel, or steel pipe. The rollers included in the general hatch cargo set are made of hardwood and are 3 3/4 inches in diameter and 4 feet long. Single rollers are used to move heavy cargo in a hold.

c. Gravity conveyors are normally made in 10-foot sections. They may be either wheel or roller type. Roller conveyors (fig 4-18) may be set up in the hold to move small boxes or other suitable items of cargo from the square of the hatch into or out of the wings.

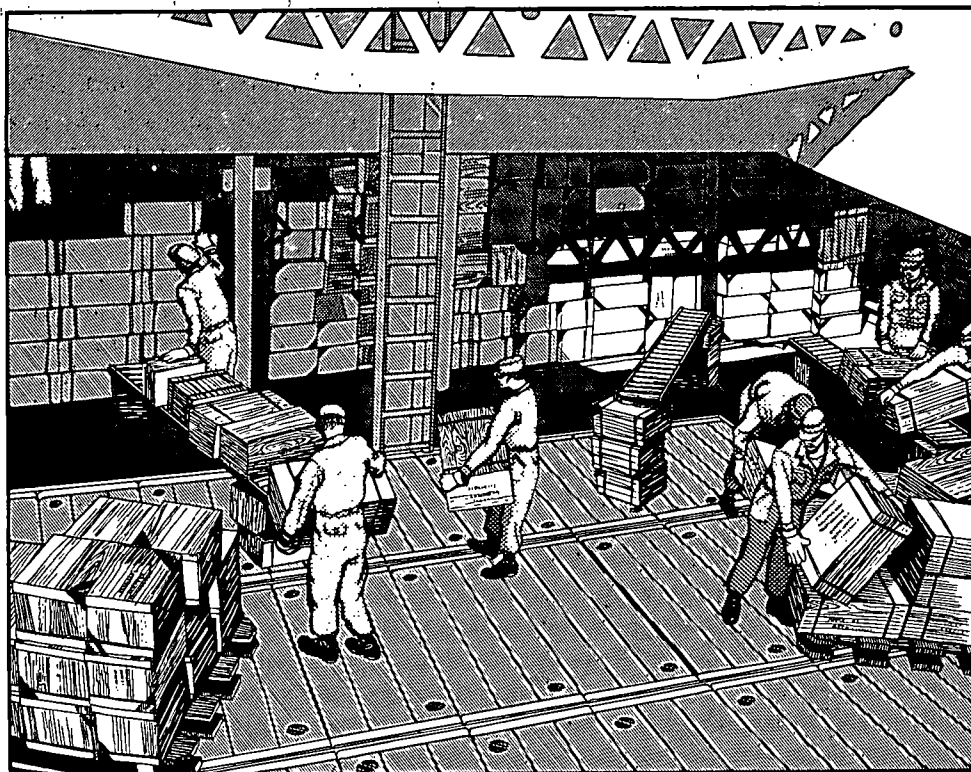


Figure 4-18. Uses of roller conveyors.

4-16. Animal-Hoisting Gear

The two types of gear for hoisting horses, mules, or cattle are—

a. The canvas sling which fits under the belly of the animal.

b. The flying stall which is a stall designed to be hoisted with the ship's gear; this is the type commonly used.

4-17. Hand Hooks and Bars (fig 4-19, 4-20, and 4-21)

Hand hooks, crowbars, and pinchbars when used properly can do much to ease the longshoreman's job. When used improperly, they can damage cargo and seriously injure personnel.

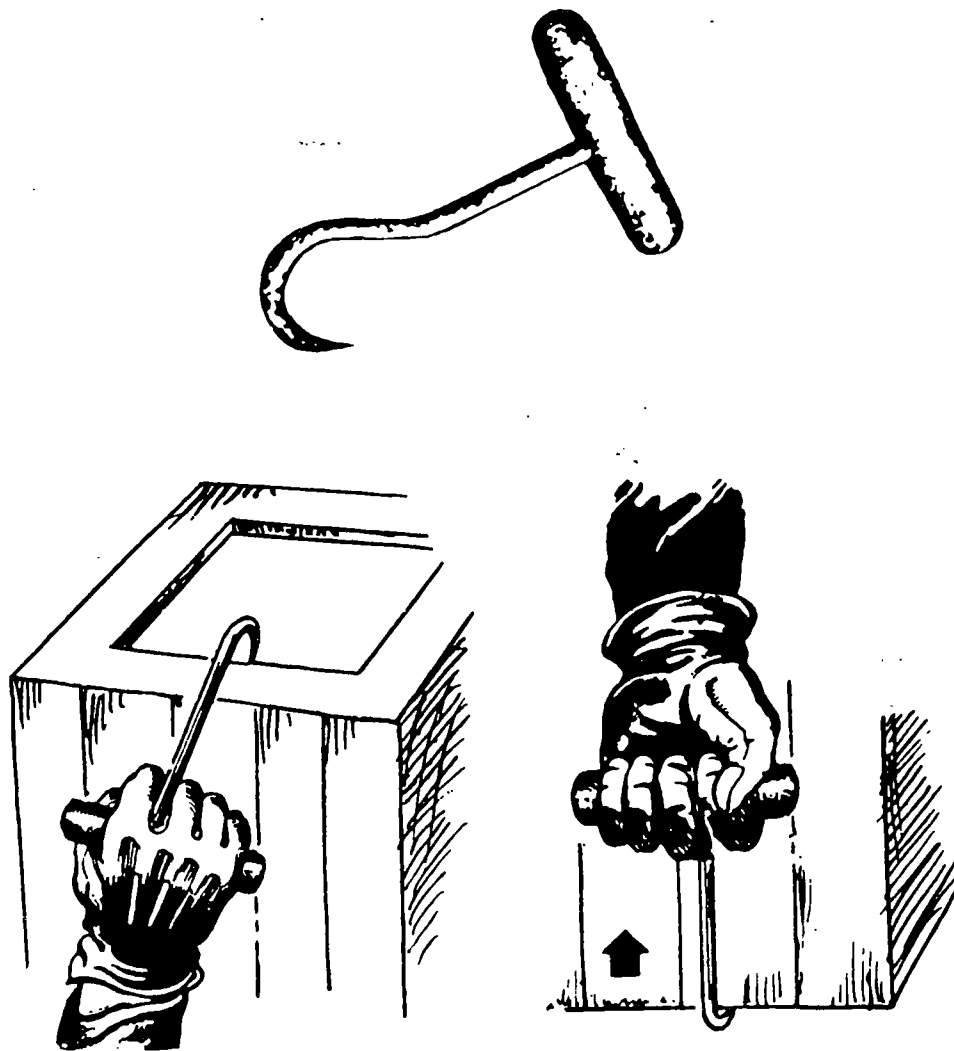


Figure 4-19. Hand hook.

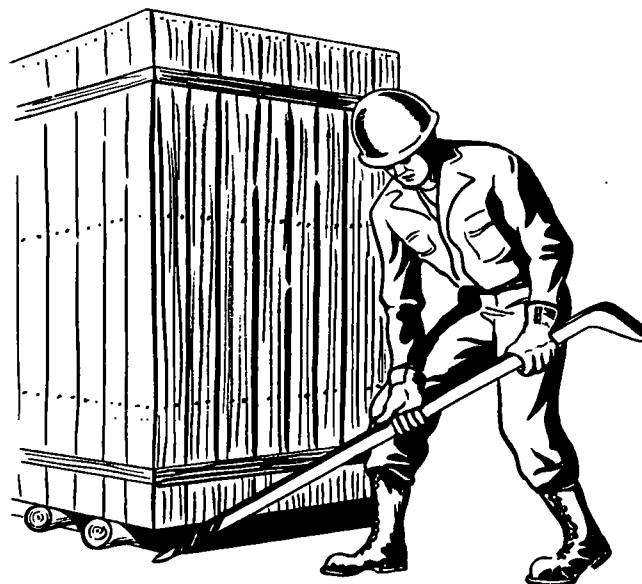


Figure 4-20. Use of pinchbar and rollers.



Figure 4-21. Lifting heavy cargo with a pinchbar.

4-18. Tag Lines

Tag lines are long lengths of light line made fast to long items of cargo and heavy lifts for the purpose of controlling the swing of the draft as it is being hoisted or lowered.

4-19. Safety Precautions

a. The proper use of cargo handling gear will make the loading and discharging of vessels safer and easier. The following safety precautions should be followed when selecting and using cargo handling gear:

- (1) Inspect all gear before it is used.
 - (a) Check slings for kinks, broken strands, frayed strands, and parting splices.
 - (b) Check shackles to insure that pins are straight and screwed in all the way.
 - (c) If a hook shows signs of straightening out, discard it and replace it with a serviceable hook.
 - (d) Check chain slings for signs of stretching.
- (2) Know the safe working load of all gear (TM 5-725 and app A of this manual).
- (3) Use shackles when handling heavy loads because they are stronger than hooks.
- (4) Do not exceed the safe working load of any part or the rigging or of the cargo handling gear at any time.
- (5) When using open hooks to hold snatch

blocks, mouse the hook and the gate of the snatch block.

(6) Do not permit kinks, twists, or knots to form in slings.

(7) Do not permit a sling to cross an unprotected sharp corner or edge.

(8) Be sure that hoisting slings are properly positioned on cargo hooks. Never carry a load on the point of a hook.

(9) Check welded rings and hook eyes periodically for cracks and distortion.

(10) Never overload a sling or apply loads suddenly.

(11) Never be too confident of a new sling; the fact that it is new is no reason for overloading it.

(12) Remember that as the angle of a sling is increased, its ability to support a load decreases. Whenever possible, avoid angles of less than 45° from the horizontal.

(13) When handling long drafts of cargo such as dunnage, pipe, and lumber, use tag lines and two slings.

(14) Never place a strain on the side of a pad eye.

(15) Condition all personnel to treat a draft as if it could fall at any instant.

b. Accidents caused by failure of cargo handling gear can usually be avoided by careful

selection and use. Select the gear with care and, after selecting it, inspect it thoroughly for serviceability before using it. Never use a piece of gear just because it happens to be handy.

4-20. Care of Cargo Handling Gear

Cargo handling gear will last longer if it receives proper care and maintenance. The following simple rules will help prolong the life of the gear:

- a. Lubricate wire rope slings periodically. A lubricated sling will outwear a dry sling 5 to 1.
- b. Clean cargo handling gear regularly.
- c. Hang manila rope slings to dry before storing.
- d. Keep gear not in use in the gearbox or locker to prevent damage.

CHAPTER 5

MATERIALS HANDLING EQUIPMENT

5-1. General

Properly utilized, materials handling equipment can do much to reduce the uneconomical use of manpower and the multiple handling of cargo moving through terminals.

a. Greatest economy is achieved when the handling of materials is well planned and coordinated. Cargo should be received and spotted at the pier in such a way as to facilitate the orderly loading of the ship.

b. Breakdowns can be avoided through an effective maintenance program and by anticipating repairs and replacements. A regular inspection and checkoff system for lubrication and replacement is necessary.

c. High productivity with economy is impossible without safety. Operating personnel must be constantly reminded to observe safety regulations.

5-2. Forklift Trucks (fig 5-1 and 5-2)

Forklifts provided for units engaged in military cargo handling may range in capacity from 4,000

to 15,000 pounds and have lift heights ranging from 144 to 210 inches. They are gasoline-, diesel-, or electric-powered vehicles and are used on paved surfaces or rough terrain. The rough terrain forklift is designed to move cargo off the road and over unimproved or soft surfaces, such as deep sand, mud, and snow. It has four-wheel power steering with independent controls for front and rear wheels. The steering operates all wheels in the conventional manner. A lever determines two-wheel steering, four-wheel crab steering, and four-wheel cramp steering. It has a ground clearance of 14 inches and can negotiate slopes up to 45 percent. The forks are power-operated and may be tilted forward or backward to angles up to 45°, and to either side at angles up to 10° from the horizontal. The loaded forks may be extended from the retracted position a minimum of 21 inches at 24 inches above ground level. Electric forklifts are primarily used for handling ammunition. Gas and electric forklifts are especially useful aboard vessels due to the increase in unitized cargo.

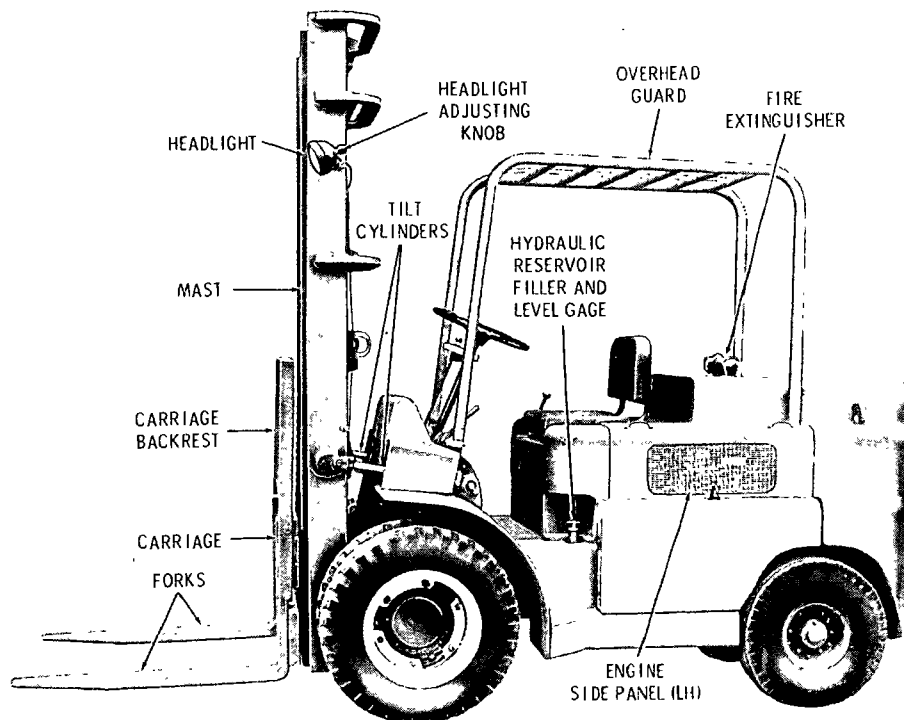


Figure 5-1. Forklift truck.

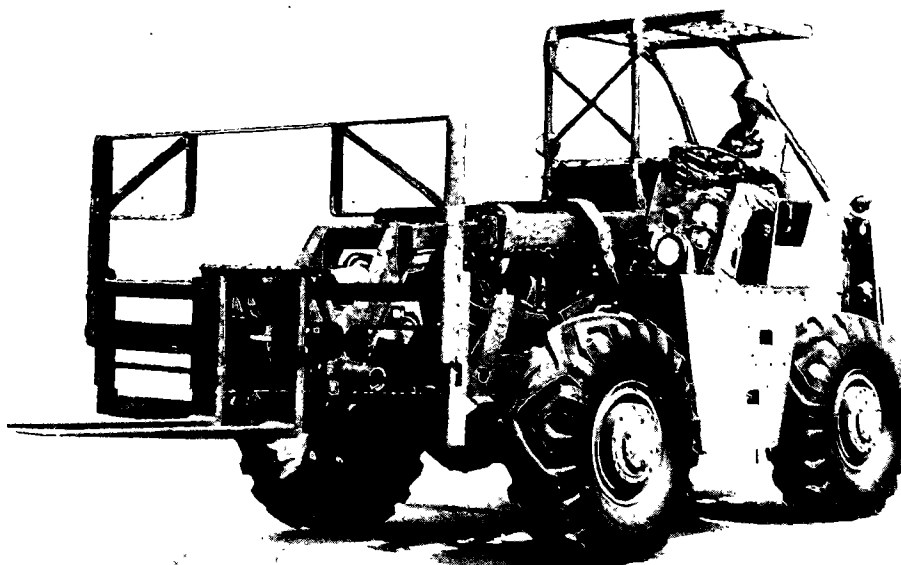


Figure 5-2. Rough terrain forklift.

5-3. Tractors, Trailers, and Handtrucks

a. A warehouse tractor (fig 5-3) is a short compact vehicle affording a minimum turning radius. It is usually equipped with a sheet-steel bumper for pushing other equipment and a towing hitch in the rear for towing a train of warehouse trailers.

b. A warehouse trailer is a small-wheeled vehicle for transporting cargo on a smooth surface. It is generally pulled by a tractor (fig 5-3), but it can be pushed as a four-wheel hand-truck.

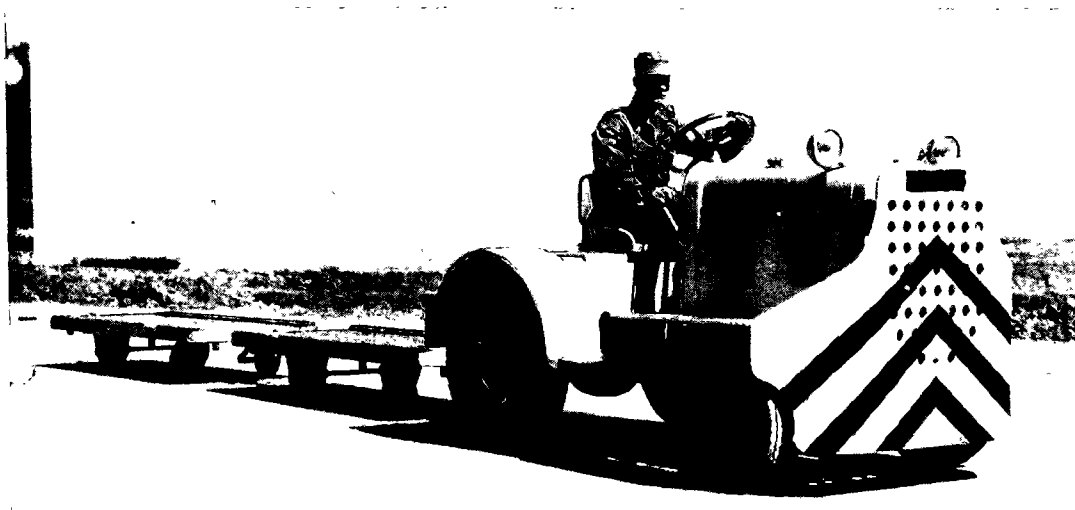


Figure 5-3. Tractor pulling trailers.

c. Handtrucks are used for moving packages too heavy to be moved by hand and for increasing

the unit load of small packages on occasional short trips (fig 5-4).



Figure 5-4. Handtruck.

5-4. Pallet Jacks (fig 5-5)

a. The pallet jack is a low-level hydraulic lift suitable for the horizontal movement of certain types of pallets. It cannot be used for tiering. It can be operated by one man.

b. The pallet jack is low enough to be passed through the opening in the bottom of a pallet, but

when the pallet is raised the rear wheels must have clearance to reach the floor or deck. The general purpose, four-way entry pallet is designed so that it can be moved with a pallet jack. The pallet jack is not suitable for moving stevedore pallets.

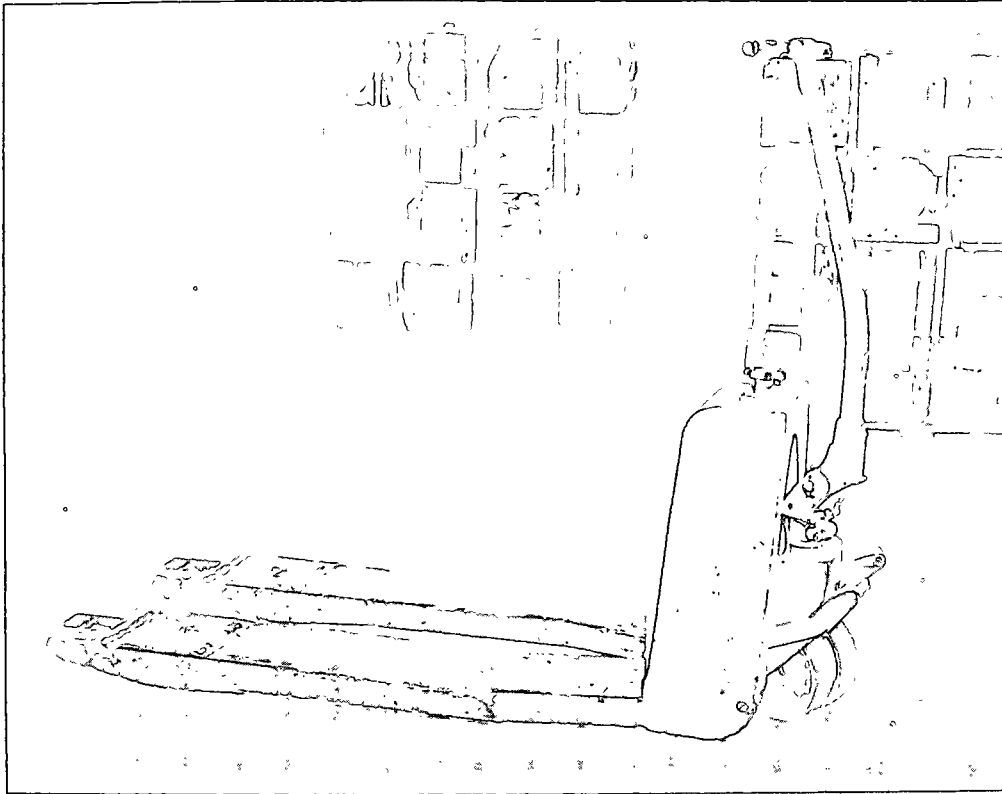


Figure 5-5. Pallet jack.

5-5. Cranes

a. *Rough Terrain Cranes* (fig 5-6). These cranes are diesel-driven, wheel-mounted, and designed for operation in rough terrain. The one

shown in figure 5-6 has a 20-ton lift capacity, a 30-foot boom, and can be equipped with a bulldozer blade and a 20-ton capacity block-and-tackle.

b. Crawler Cranes.

(1) Crawler cranes are especially useful on beaches, where ordinary wheeled vehicles would bog down. There are several types, ranging in capacity from 5 to 50 tons.

(2) In addition to unloading barges and lighters on beaches, crawler cranes are used to load and unload other modes of transportation at rail and truck points and on piers. They can be loaded on lighters, where they are lashed down and used as floating cranes, provided the lighters are properly ballasted.

c. Floating Cranes (fig 5-7).

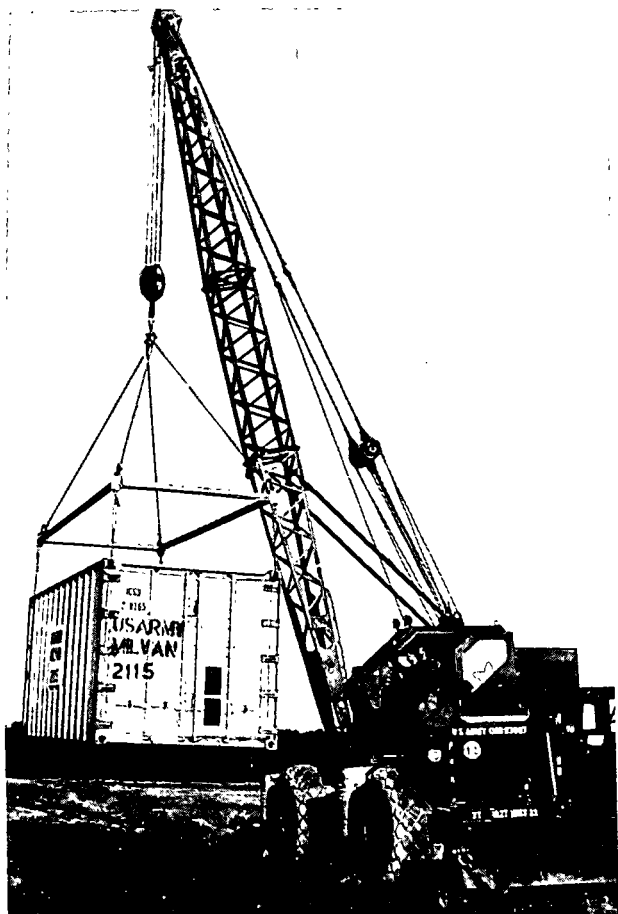


Figure 5-6. Rough terrain crane, 20-ton.

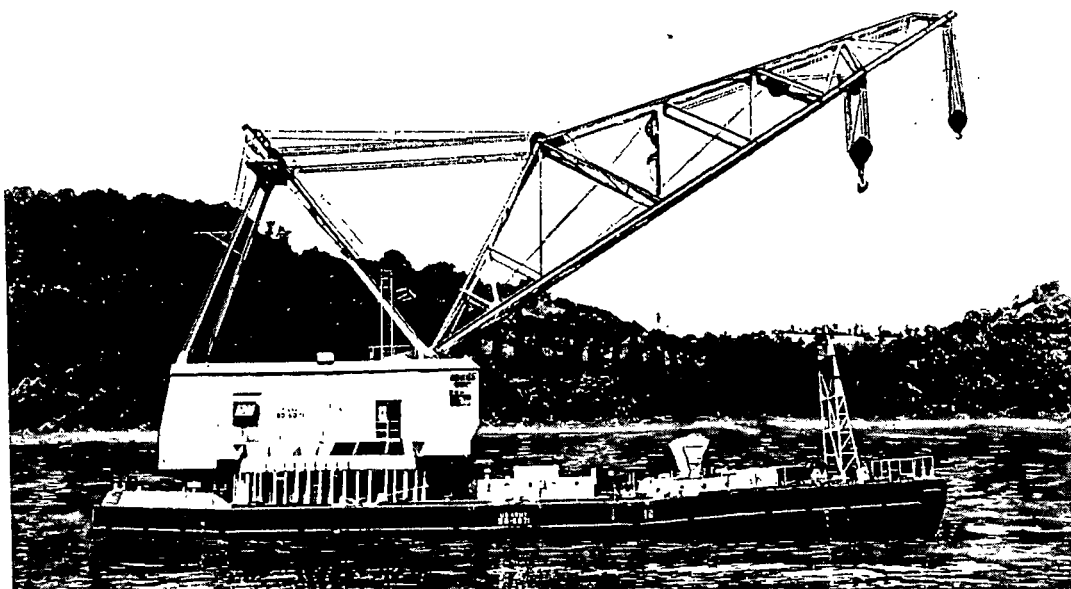


Figure 5-7. Floating crane (89 long tons, 100 short tons).

(1) Floating cranes vary in lifting capacity; some commercial cranes have capacities up to 250 long tons. The two standard floating cranes found in the military inventory have capacities of 60 and 89 long tons.

(2) Floating cranes work the offshore side of a vessel. Heavy lifts are discharged to the deck of the crane or to barges tied alongside, or the 89-ton crane may reach across the ship and discharge the lift on the pier or to clearance carrier equipment. The 60-ton crane may reach across the ship with the 15-ton auxiliary hoist.

(3) Detailed information on floating cranes may be found in TM 55-511.

d. *Gantry Cranes (fig 5-8).* Gantry cranes range in capacity from 3 to 45 tons. The legs of the cranes are supported on wheels that run on tracks on the pier apron. Gantry cranes are used for loading and discharging barges, railcars, and trucks; for handling heavy lifts aboard vessels; and for handling general cargo in place of the ship's gear.

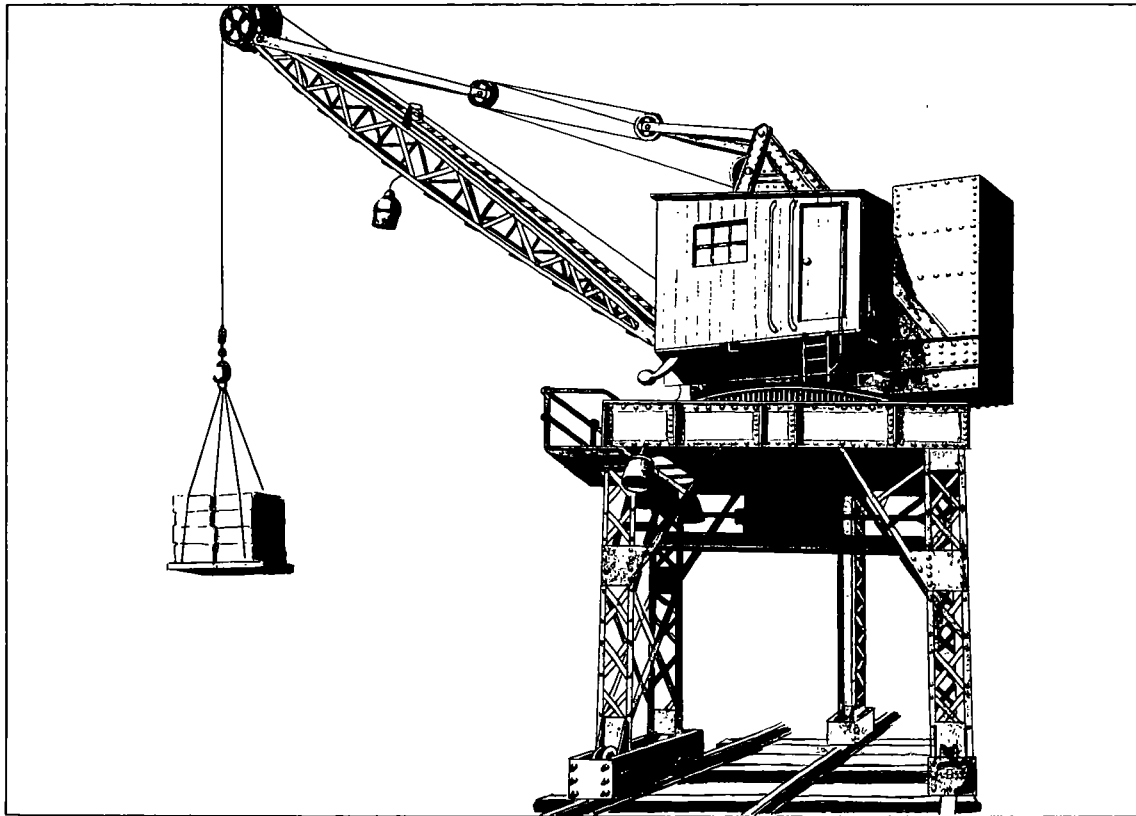


Figure 5-8. Gantry crane.

CHAPTER 6

LOADING AND DISCHARGE

Section I. GENERAL

6-1. Nomenclature of Cargo Hold

Before stowing cargo in a hold, personnel should be familiar with the nomenclature and purpose of

the various parts of the hold and the fittings and equipment. Figures 6-1 and 6-2 show a ship's forward and after holds with identifying terms.

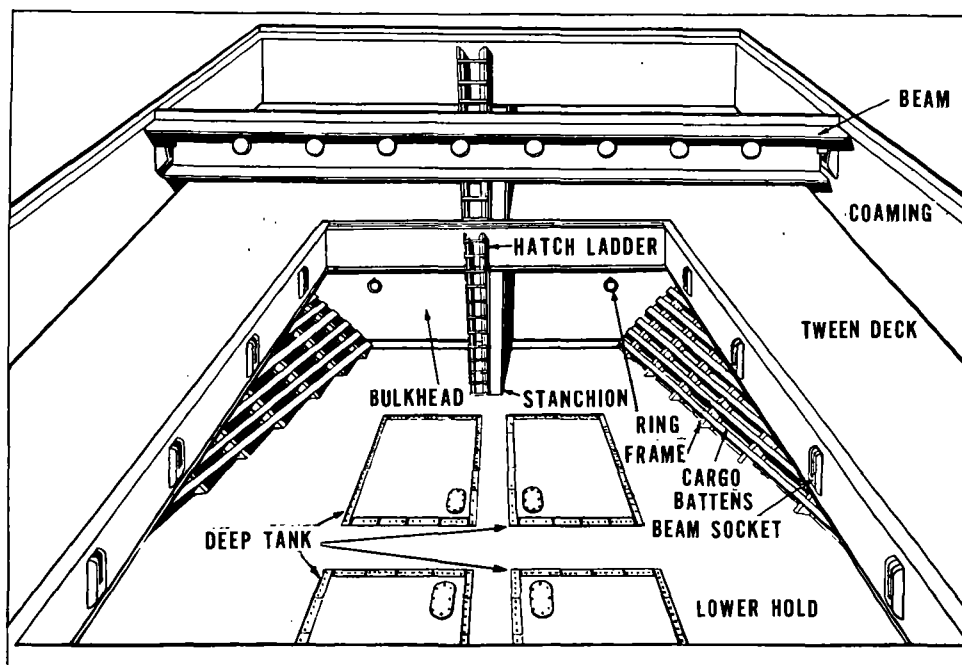


Figure 6-1. Forward hold.

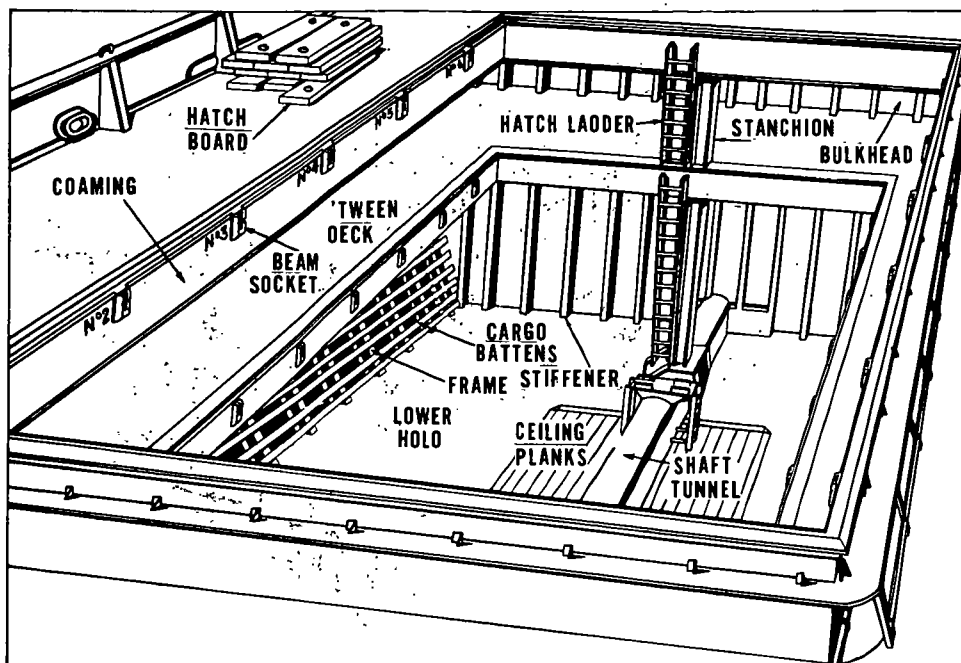


Figure 6-2. After hold.

a. Batten Cleat. Metal cleats welded or riveted to the outer edge of the coaming stiffener for holding hatch battens and edges of tarpaulin covers.

b. Beam Socket. A steel fitting riveted or welded to the inner surface of the hatch coaming to support the ends of the hatch beam.

c. Bulkhead. Any vertical partition, whether fore-and-aft or athwartship, that separates one compartment or space from another.

d. Deep Tanks. Portions of a vessel's lower hold partitioned off and constructed to carry liquid cargo, ballast, or dry cargo. They are bound at each end to reinforced watertight bulkheads and at the top by a watertight steel deck.

e. Frames. Transverse girders to which the outside plating is secured. They form the ribs of the hull and extend from the keel to the highest continuous deck.

f. Hatch Batten. Flat iron bars used for securing tarpaulins on a hatch. Cross battens hold the tarpaulins down and side battens hold them in against the coaming.

g. Hatch Beam. A portable transverse beam across a cargo hatch that supports hatch boards.

h. Hatch Boards. Wooden boards about 4½ feet long, 2½ feet wide, and 2-or-3 inches thick usually reinforced with metal at the ends. Most hatch boards have recessed handles or rings at

each end to permit easy handling. Hatch boards are supported by hatch beams and serve as hatch covers.

i. Hatch Coaming. The vertical plating built around a hatch to serve as a framework for the hatch beams and hatch covers, to secure the tarpaulins, and to prevent water from seeping into the cargo hold.

j. Hatch Wedge. A triangular piece of hardwood having good swelling characteristics when wet. It is used for securing hatch battens and thus holding tarpaulins in place. The wedge is driven tightly between the cleat and the batten.

6-2. Opening Hatches

a. Hatch Boards and Eye Beams. The procedure below should be followed when opening hatches covered with hatch boards supported by eye beams.

(1) Drive out the wedges and remove the battens.

(2) Lay the battens on the deck close to the coaming.

(3) Gather all the wedges and stow them in one place.

(4) Remove tarpaulins, one at a time, in the following manner:

(a) Grasp the edge of the top tarpaulin nearest the winches and pull it all the way to the opposite end of the hatch (fig 6-3).

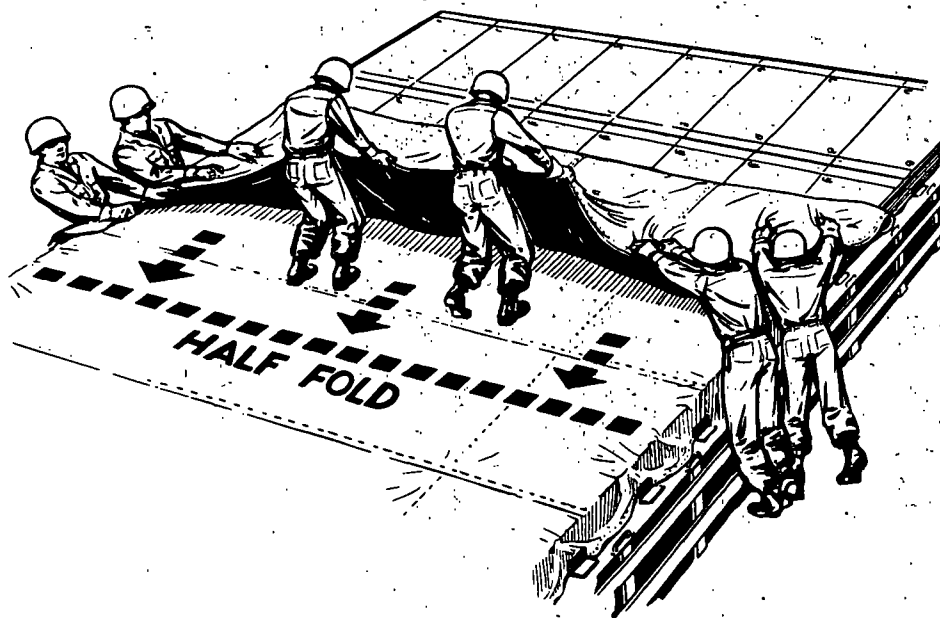


Figure 6-3. First fold in hatch tarpaulin.

(b) Grasp the fold and pull it to the same end of the hatch as the leading edge.

(c) Repeat this procedure until the tarpaulin lies athwartship on the hatch in a folded strip 3 to 4 feet wide.

(d) Starting on the side of the deck over which cargo is to be worked, fold the tarpaulin to the opposite side.

(e) Remove each succeeding tarpaulin in the manner described above, and stack them clear of the hatch.

(5) Remove hatch covers.

(a) Begin removal of hatch boards at the inshore (working) side of the vessel and remove them to the offshore (nonworking) side, so that the men removing the hatch boards will have a firm footing at all times.

(b) Remove the hatch boards in sequence as shown in A, figure 6-4, if the vessel is to be unloaded from the port side, and as in B, figure 6-4, if the vessel is to be unloaded from the aft side.

		FORWARD									
WORKING SIDE	A	1	6	11	16	21	26	31	36	NONWORKING SIDE	
		2	7	12	17	22	27	32	37	STORE HATCH BOARDS ON THIS SIDE	
		3	8	13	18	23	28	33	38		
		4	9	14	19	24	29	34	39		
		5	10	15	20	25	30	35	40		
		AFT									

		FORWARD									
NONWORKING SIDE	B	40	35	30	25	20	15	10	5	WORKING SIDE	
		39	34	29	24	19	14	9	4	STORE HATCH BOARDS ON THIS SIDE	
		38	33	28	23	18	13	8	3		
		37	32	27	22	17	12	7	2		
		36	31	26	21	16	11	6	1		
		AFT									

Figure 6-4. Sequence of hatch cover removal.

(c) Hatch covers should be stacked no closer to the hatch than 3 feet and no higher than the hatch coaming.

(d) Stacks should be neat and solid.

(6) Remove the hatch beams in the following manner:

(a) Insure that the beams are not locked in place.

(b) Hang the beam bridle, with the tag lines attached to each leg, on a cargo hook. The safe practice to follow when hooking hatch beams is to hold the hook in the right hand (fig 6-5). By following this rule, the hooks will automatically be placed on opposite sides of the beams, a position that is necessary if they are to lift straight.

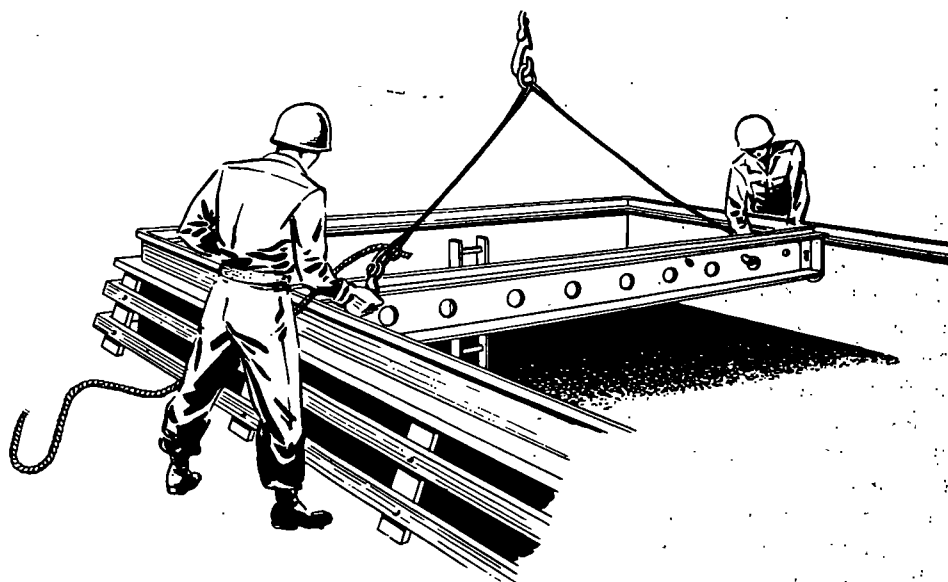


Figure 6-5. Hooking up hatch beam bridle.

(c) Place dunnage for the beams on the deck on the side opposite to that on which the cargo is to be worked.

(d) Using the taglines to guide the beams, land them on the dunnage. As a safety precaution, beams should be placed on their sides to prevent toppling (fig. 6-6).

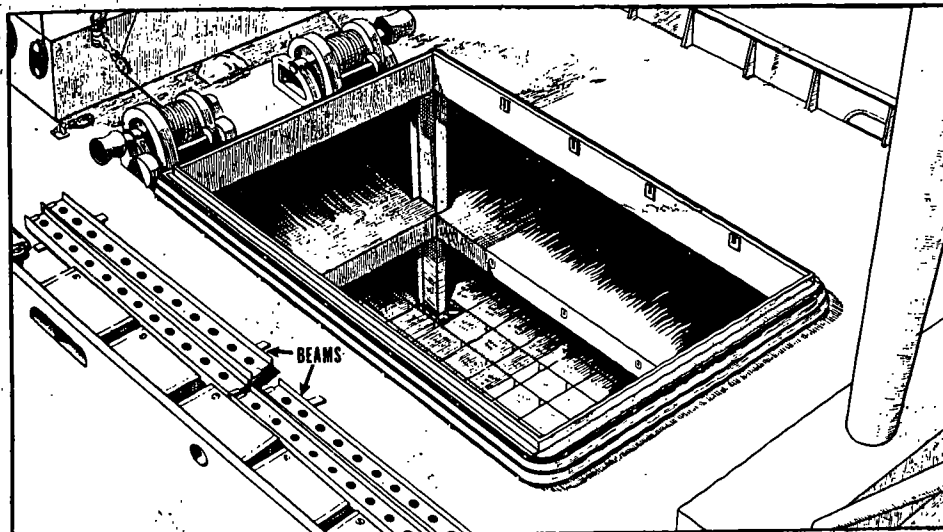


Figure 6-6. Beams on sides as safety precaution.

(7) When the last beam has been removed and there is no further need for the beam bridle, remove the cargo hook from the bridle and leave the bridle in the beam.

b. Hatch Boards and Roller Beams. On vessels equipped with roller-type hatch beams, tarpaulins and hatch boards are removed as described in paragraph a (4) through (7) above. However, it is not necessary to remove the beams. When all boards have been removed, the beams are rolled to either one or the other end of the hatch by the rollers.

c. Ponton Hatch Covers (fig 6-7 (1)). Many vessels are fitted with ponton hatch covers which are constructed of welded steel forming a series of

box girders about 12 inches deep over the hatch. At each corner of the ponton is a special casting in which a hook can be inserted. The pontons are seated on a rest bar of flanged plating welded to the inside of the coaming about 12 inches from the top. To open this type of hatch, the tarpaulins are removed (para a (4) above) and the pontons are hoisted out of the hatch opening and stacked on deck on the side opposite the working area. Strips of dunnage should be laid on the deck and between the pontons when they are stacked. Pontons should never be stacked higher than the coaming to prevent the possibility of the pontons accidentally being pushed into the hatch by a swinging draft.

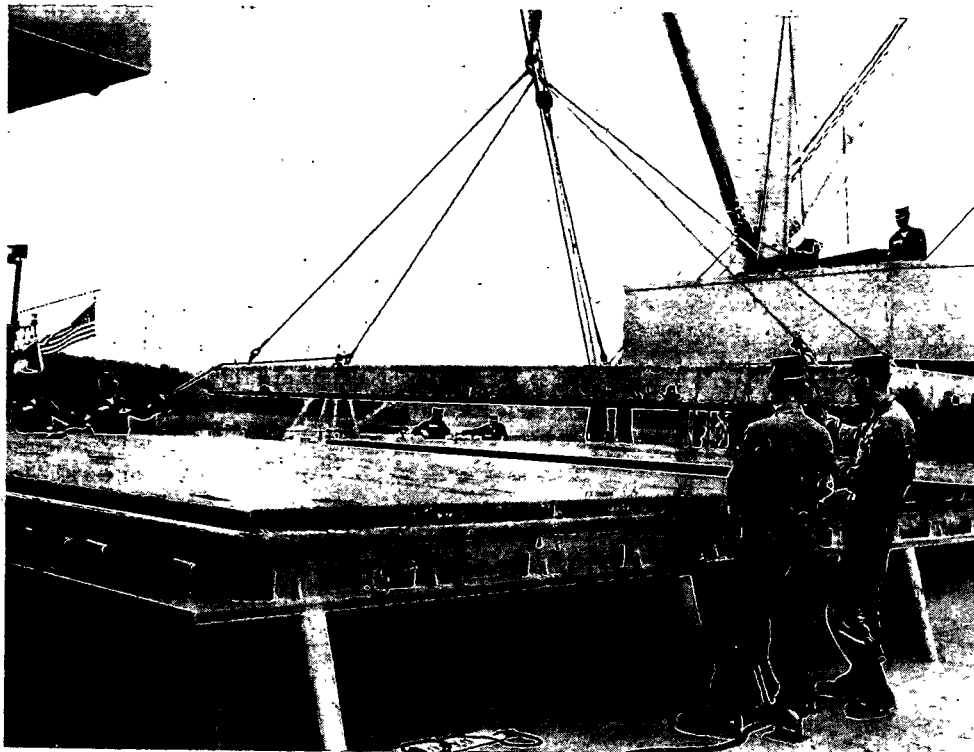


Figure 6-7(1). Ponton hatch covers.

d. *Quick Opening Hatch Covers (fig 6-7(2))*. The three principal types of folding, quick opening, metal hatch covers—single-pull, Mege, and hydraulic—are watertight and require no tarpaulins. (A gasket around the perimeter of the

cover keeps the hatch watertight by setting against a knife edge. The gasket is held in place by dogs around the outside edge of the cover. Folding hatch covers used in 'tween decks usually are not watertight.)

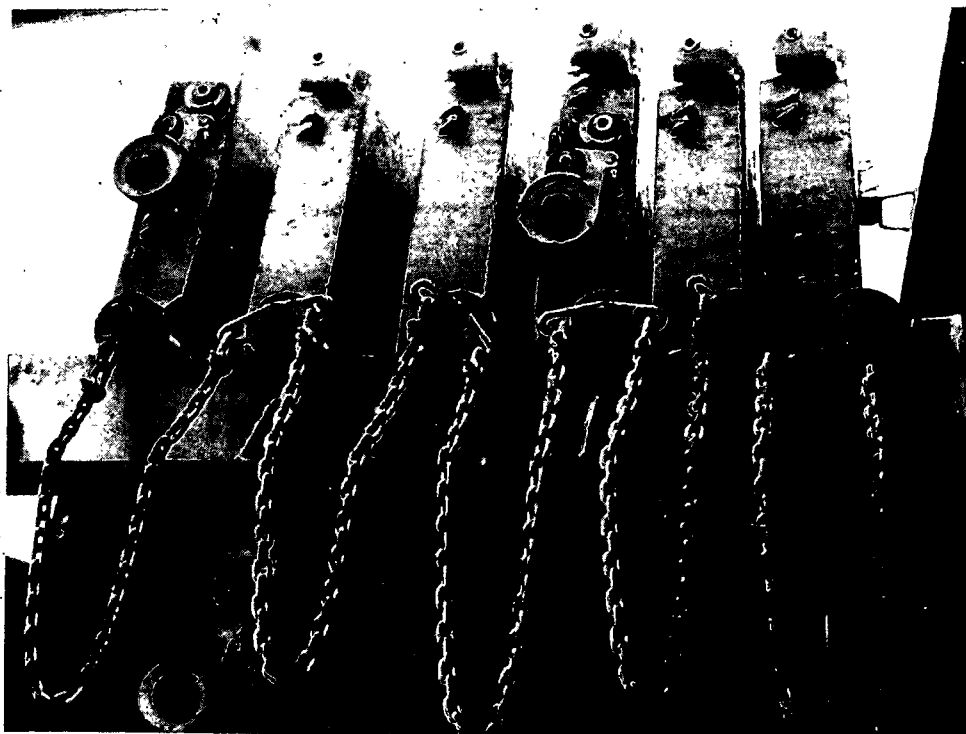


Figure 6-7(2). Quick opening hatch covers.

(1) The single-pull type is pulled forward or aft by the cargo fall. As the leaves or sections reach the end of the hatch, they tilt upright into a vertical stowage position on deck at the end of the hatch.

(2) The Mege type consists of two to four large sections per hatch. These sections are raised from the sealed or closed position by upward pressure against wheels located at the corners of the section. The cover is then raised by the cargo fall attached to permanently installed messenger. The sections are hinged at each end of the hatch and along a transverse seam joining two adjacent sections. When the hatch is open, these sections stand upright at the end of the hatch.

(3) Hydraulically-operated hatch covers are a new development, adding increased speed to quick opening covers.

e. Refrigerator Ships. Refrigerator ships are

equipped with insulated hatch covers or plugs, in addition to conventional ones. Insulated hatch covers are thick and airtight, with tapered edges lined with insulating material. They are fitted over a refrigerator hold to help contain the cold air. Refrigerator plugs are fitted with rings or slotted ends to accommodate the bridle for easy removal.

6-3. Closing Hatches

a. Before a vessel sails, the hatches must be securely closed to protect cargo in the hold from sea, wind, and rain. Hatch beams and boards, pontons, or folding hatch covers are replaced in the reverse order of that in which they were removed. Special care should be taken when replacing tarpulins.

b. Normally, the longshoremen close the hatches and spread one tarpaulin over the hatch. The ship's crew completes the battening down.

Section II. STOWAGE OF GENERAL CARGO

6-4. General

a. The following factors must be taken into account for proper stowage:

(1) The vessel should not be damaged nor personnel endangered by movement of the cargo.

(2) Cargo should not be damaged by movement of the vessel at sea.

(3) Full use should be made of the cargo space in order to maximize the carrying capacity of the vessel.

(4) Cargo should be stowed with due consideration for efficient discharge.

b. Damage to cargo can be greatly reduced by employing a few simple rules of stowage:

(1) Cargo should be stowed so that the strongest structures of an item will bear the greater pressures and weights of that item.

(2) Each item of cargo should be stowed so that it supports and strengthens the entire load.

(3) Dunnage should be used in required quantities.

(4) Stowage and special handling labels such

as "Use No Hooks," "This Side Up," "Do Not Drop," etc., should be strictly complied with to prevent damage to the cargo.

(5) If it is necessary to walk on top of or land drafts on cargo such as cardboard cartons, lightly constructed cases, bags, and crates, a layer of dunnage should be placed over the cargo to protect it from damage.

c. To obtain maximum use of the carrying capacity of a hold, broken stowage should be minimized. This can be accomplished by—

(1) Careful prestowage planning so that cargo will fill the hold without leaving large voids.

(2) Proper supervision during loading to insure correct stowage and fitting of irregularly shaped packages.

(3) Maximum use of filler cargo where void spaces occur.

(4) Nesting of cargo to use space that would otherwise be wasted.

(5) Avoidance of excess dunnage.

(6) Use of dunnage for false decks to permit additional stowage (fig. 6-8).

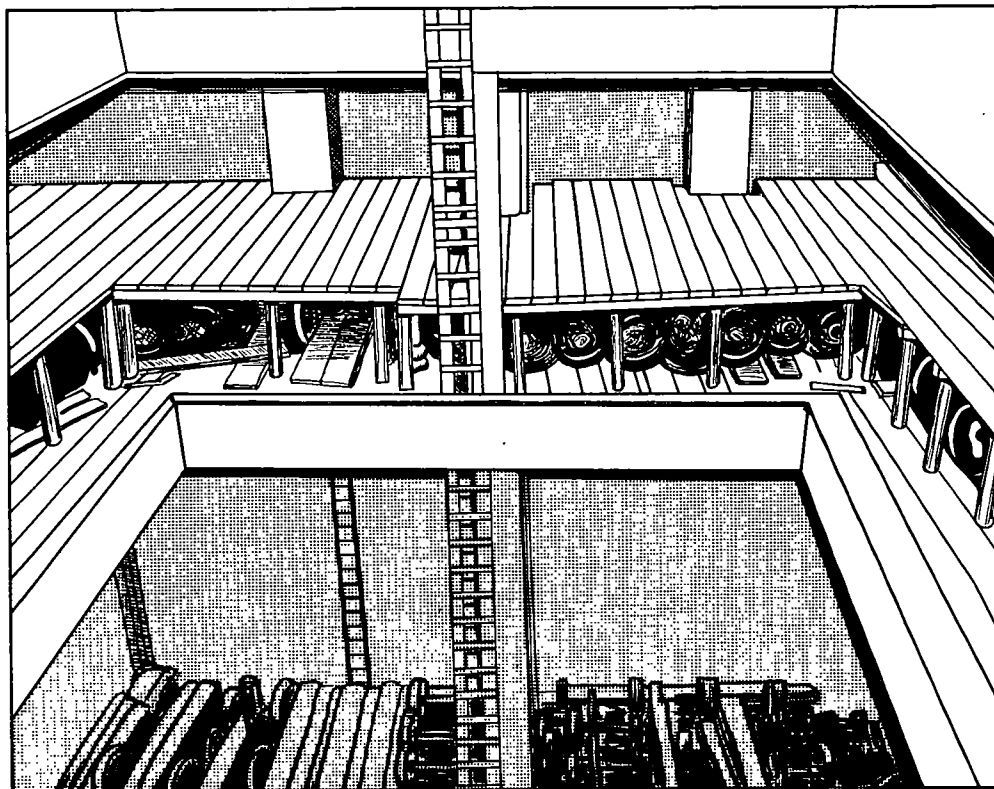


Figure 6-8. False deck over car wheels to permit additional stowage of cargo.

6-5. Lashing Cargo

a. Forces Acting on Cargo.

(1) The shifting of cargo during a voyage can result in considerable damage to cargo and ship.

Good stowage practices and the proper use of lashing and dunnage, including shoring, tomming down, blocking, and bracing, will do much to prevent damage. Considerable force is exerted on cargo at sea which makes it difficult for cargo to remain in its stowed position. Resistance to such forces must be provided to prevent the cargo from shifting as the vessel rolls and pitches. All deck cargo, heavy vehicles, and other cargo that can shift must be lashed, in addition to shoring, blocking, and bracing. Cargo stowed below deck can usually be secured against shifting by shoring, blocking, and bracing with timbers firmly wedged and nailed. This does not preclude the use of lashing when pad eyes that provide the proper leads are available and when the lashings are accessible for tightening during the voyage.

(2) The securing of cargo is especially important when a vessel is sailing in convoy and the master is not permitted to alter course or speed to avoid rough seas or foul weather. Since convoy sailing also exposes deck cargo to greater hazards, particular attention should be given to the type, strength, and number of the lashings.

b. Basic Lashing Procedure.

(1) All parts of a lashing should have equal strength. Frequently, the strength of the wire rope used in lashing is twice the strength of the turnbuckle; this is not advisable. The wire rope and turnbuckle should be of approximately equal strength.

(2) Lashing that directly counteracts the force to be met is the most desirable. Since the greatest forces are usually horizontal, the angle that the lashing forms with the deck should not exceed 45°.

c. *Lashing Material.* Lashing should be a type that can be quickly applied and removed. Selection of lashing materials is governed by their availability and the type of cargo to be secured.

(1) Wire rope, 5/8-inch in diameter, is used most frequently for heavy cargo and large items.

(2) Chain is often used for securing lumber and extremely heavy objects on deck. The most common size chain is 3/4-inch in diameter. Wire rope may also be used for this type of cargo.

(3) Steel or wrought-iron bars are exceptionally good for securing boxed or rectangular cargo.

(4) Steel strapping may also be used for lashing.

(5) Turnbuckles or other tightening devices should be used with all types of lashing to permit tightening enroute.

d. Storage. Lashing materials are stored in the port dunnage yard, along with dunnage. Inventory control procedures should be set up for these materials in such a manner that zero balances will not occur, since very costly demurrage costs accrue when vessel outloading is halted for lack of blocking, bracing, and lashing materials.

e. Precautions in Lashing.

(1) Dunnage or metal saddles should be placed between the cargo and the lashing to prevent the lashing from cutting into the cargo (fig 6-37).

(2) Because of the pressure of the lashing on the cargo, extra blocking or bracing may be necessary to prevent the cargo from being crushed or damaged.

(3) A continuous length of wire rope should not be used in lashing because, if the rope is broken at any point, the protection of the entire lashing is lost. A continuous lashing is as effective as one lashing regardless of how many times it is wound around the item.

6-6. Dunnage

a. Dunnage Uses. Dunnage is used to—

- (1) Prevent cargo from shifting and chafing.
- (2) Chock off and secure containers.
- (3) Block off broken stowage or space that cannot be filled with filler cargo.
- (4) Protect cargo from contact with water or other liquids that may get into the holds.
- (5) Provide air passages for effective ventilation.
- (6) Provide spaces for air circulation in refrigerated holds.
- (7) Distribute weight.
- (8) Separate cargoes.

b. Frequently Used Dunnage Materials. The materials frequently used as dunnage are:

(1) Rough lumber (consisting of pieces of pine, hemlock, spruce, or similar woods of uniform thickness and of random widths and lengths) is the most common type of dunnage.

(2) Paper is often used to protect cargo from dirt, dust, and moisture and to separate shipments.

(3) Burlap is made up in rolls or squares and may be used in the same manner as paper.

(4) Other materials may be used for dunnage, depending on the cargo to be stowed and the quantity of the material available.

c. Dunnaging Rules. Hard and fast rules for dunnaging cargo are not possible because of the wide variety of cargo carried, differences in atmospheric conditions, availability of dunnage material, etc. However, certain basic factors always apply:

(1) Wood dunnage should never be green and contaminated dunnage that may harm the cargo should never be used.

(2) The quantity and type of dunnage should be carefully selected to correspond to the type of cargo carried.

(3) The placement of the bottom layers of dunnage should permit any water in the hold to flow to the drains. This is accomplished by laying the first layer of dunnage so that it points toward the drains and the next layer in the opposite direction. Cargo is then stowed on the upper layer of dunnage.

d. Measuring Dunnage. The unit of measurement for lumber in the United States is the board foot; lumber is one of the most commonly used forms of dunnage. A board foot is a piece of wood measuring 12 inches by 12 inches by 1 inch (144 cubic inches).

(1) Recording the amount of dunnage used in stowing cargo requires the following formula for determining board feet:

$$\frac{\text{length (in inches)} \times \text{width (in inches)} \times \text{height (in inches)}}{144}$$

144

(2) The following represents the correct solution for a problem requiring board feet to be

Length: 10 feet (10 ft x 12 in. = 120 in.)

Width: 4 feet (4 ft x 12 in. = 48 in.)

Height: 4 feet (4 ft x 12 in. = 48 in.)

computed for a stack of dunnage 10 by 4 by 4 feet. In this problem, feet are converted to inches.

$$\frac{120 \text{ in.} \times 48 \text{ in.} \times 48 \text{ in.}}{144} = \frac{5,760 \text{ sq in.} \times 48 \text{ in.}}{144} = \frac{276,480 \text{ cu in.}}{144} = 1,920 \text{ board ft}$$

e. Dunnage Control.

(1) Dunnage is normally manifested and should be removed from the ship during discharge, unless instructions are received to the contrary. While the cargo is being worked, dunnage should be made up in drafts as it becomes available. When a draft is complete, it should be removed. This procedure will insure that dunnage is handling a minimum number of times aboard ship.

(2) The drafts may be removed from ships in cribs constructed and used in the holds or in slings. When a crib or sling load of dunnage has been discharged to the pier, the crib and/or dunnage are then moved by truck or forklift to the port dunnage yard, with the crib (if any) being returned to ship after unloading for further use. The dunnage crib in figure 6-9 was constructed from blocking and bracing material. It is 3 feet wide, 8 feet long, and approximately 4 feet high. It holds 80 to 100 board feet of dunnage.

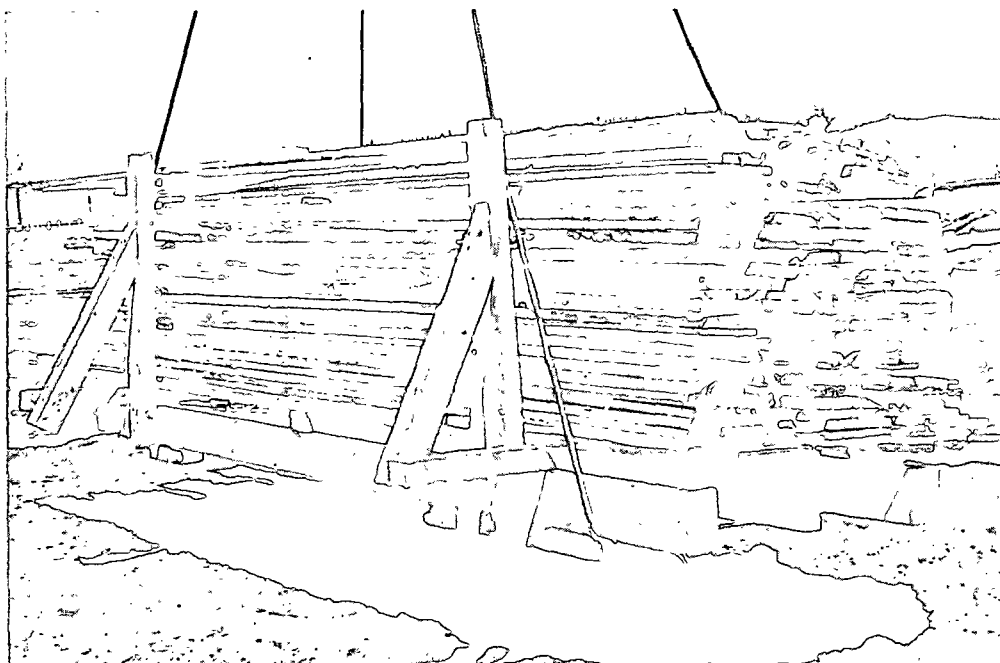


Figure 6-9. Loaded dunnage crib.

(3) Once received at the port dunnage yard, dunnage is immediately sorted and bundled according to size, denailed, stored, and accounted for.

(a) Heavy banding material ($\frac{3}{4}$ - to 1-inch wide) should be used in bundling to prevent band breakage during future ship loading.

(b) Two basic categories (not all-inclusive) into which dunnage is sorted are "timber" (4

inches or more minimum dimension) and "lumber" (4 inches or less minimum dimension).

(c) Although dunnage varies in length, it should be stacked with one end even to insure compactness and ease of handling and to facilitate the creation of aisles convenient to work in (fig 6-10).

(d) Stockage levels are maintained on inventory control cards in a visible index file.



Figure 6-10. Stacked dunnage with one end even.

6-7. Special Construction

The use of dunnage will not always meet the requirements for safety and afford the cargo complete protection from damage. Special construction may be required for the proper stowing and securing of tanks, vehicles, cranes, fuel drums, ammunition, etc.

a. *Bracing.* Strengthening an item by supporting it in a horizontal direction is called bracing (fig 6-11).

b. *Blocking.* Placing timbers or blocks next to the sides and ends of vehicles, heavy lifts, bombs, and other cargo to prevent horizontal movement is called blocking (fig 6-11). Blocking must be braced to be effective.

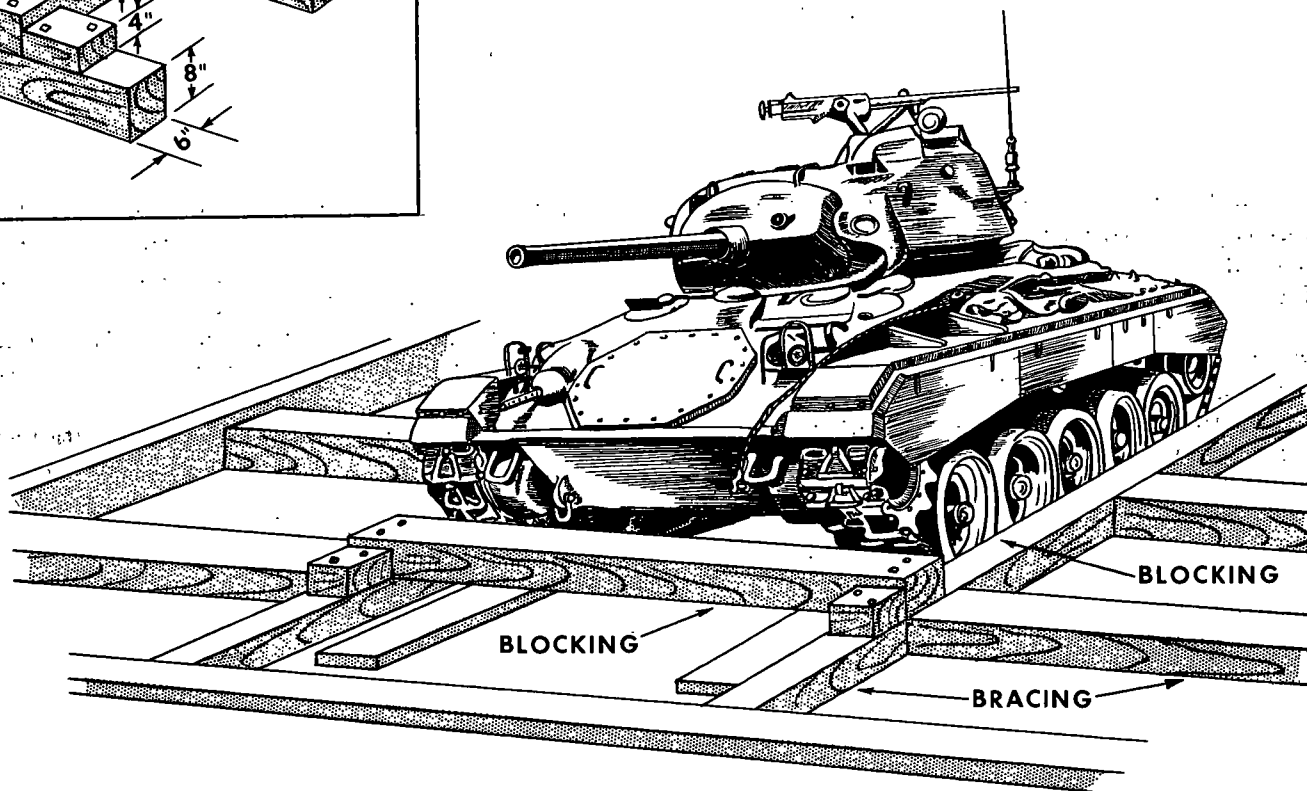
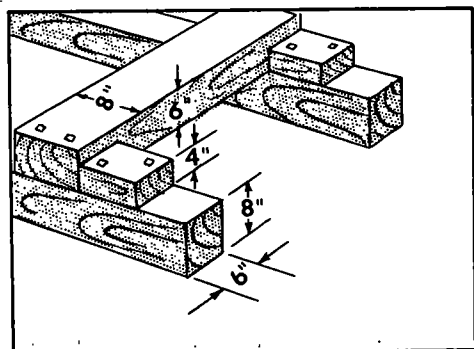
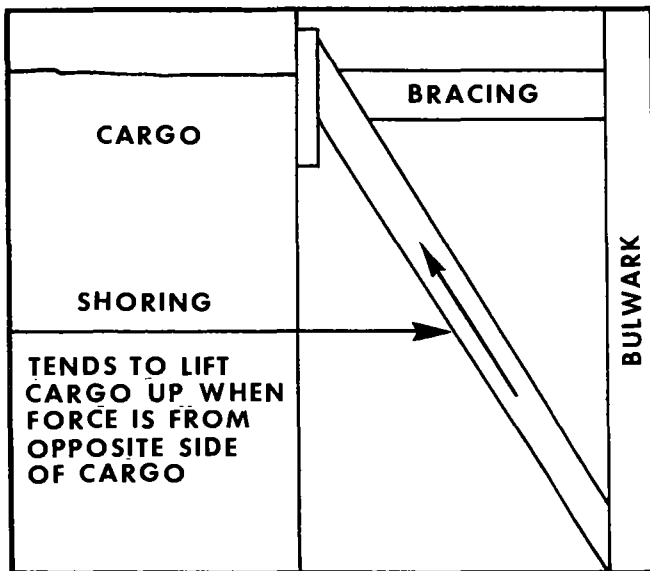


Figure 6-11. Blocking and bracing tank below deck.

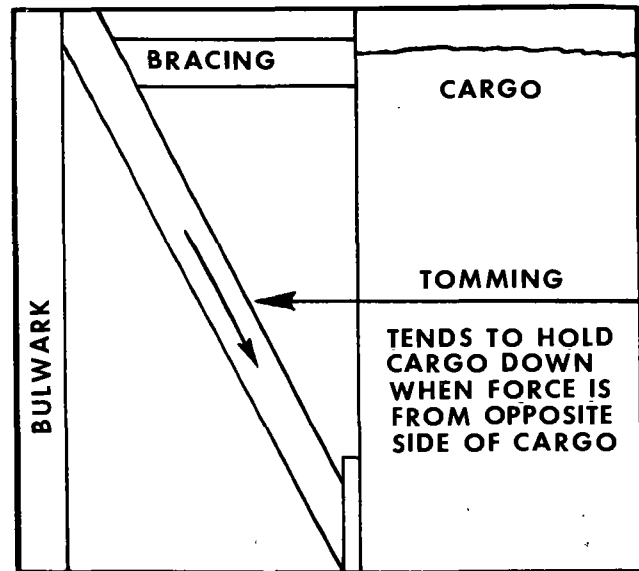
c. *Shoring*. Strengthening an item or securing cargo by supporting it from below is known as shoring (fig 6-12). When decks are shored, the shores are run from a low-level support vertically up to the deck being supported. When cargo is shored, the shores may run at an angle from a low-level support up to the cargo.

d. *Tomming*. Securing cargo by running

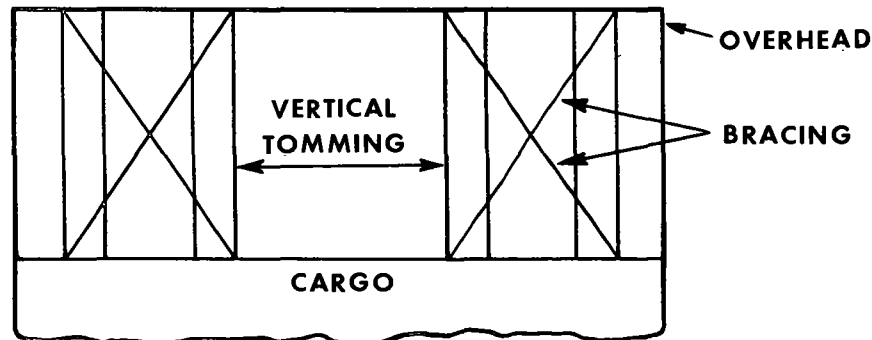
timbers from an upper support down to the cargo either vertically or at an angle is known as tomming (fig 6-12). The maximum effective length of timbers used for bracing, shoring, and tomming is equal to 30 times its minimum dimension. Thus, if a piece of timber is 4 inches thick and 6 inches wide, its maximum effective length is 10 feet ($4 \times 30 = 120$ inches or 10 feet).



① SHORING



② TOMMING AT AN ANGLE



③ VERTICAL TOMMING

Figure 6-12. Shoring and tomming.

e. *Bulkheading*. The use of vertical partitions made of dunnage to keep cargo from shifting or to keep it away from hot bulkheads is known as

bulkheading. Figure 6-13 shows the square of the hatch partitioned off to receive cargo and to equalize the pressure on the bulkheads.



Figure 6-13. Bulkheading.

f. *Cribbing.* The use of dunnage to eliminate void space in the cargo compartment is known as cribbing (fig 6-14). Cribbing is used to fill vacant space as a precaution against shifting and to maintain a level tier so that other cargo may be stowed on top.

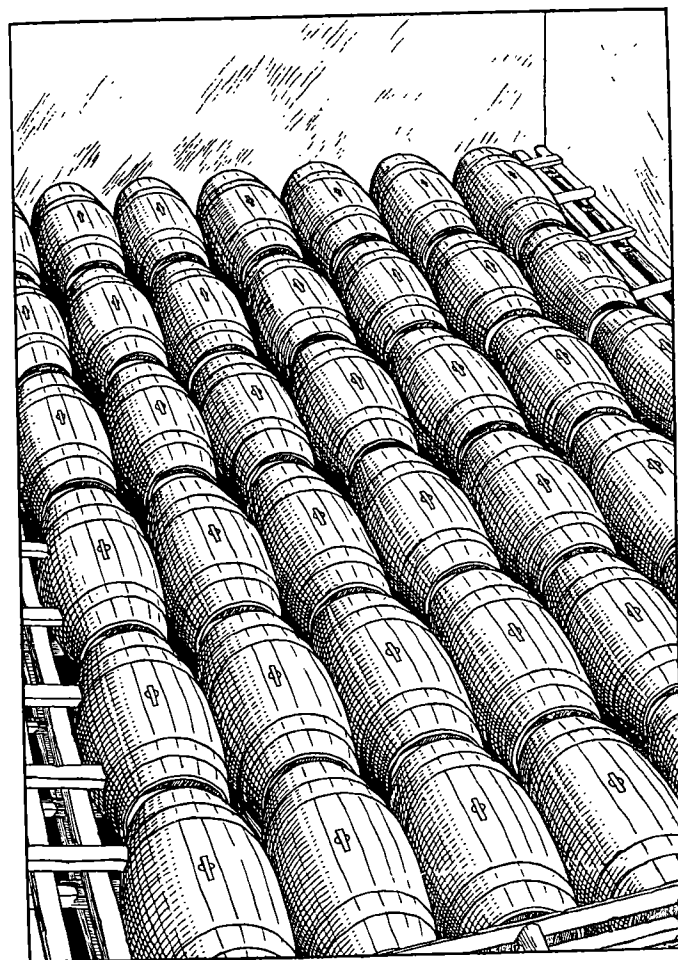


Figure 6-14. Cribbing.

6-8. Preparation of Cargo Holds

a. Cargo holds must be reasonably clean before cargo is stowed. The degree of cleanliness is determined by the type of cargo to be loaded. When refrigerator cargo is being stowed, the cargo compartment should be thoroughly inspected to insure that the hold has been cleaned since the last voyage.

b. Dunnage should be laid before the cargo is brought in.

6-9. Bagged Cargo

a. The majority of bagged commodities are shipped in containers; however, some commodities, such as bags of cement, are shipped as palletized units or as loose bags. Bagged commodities are subject to damage if stowed close to moist cargo or cargo that may sweat. Bags should be protected from direct contact with metal. Special precautions should be taken to protect bagged cargo from moisture damage. Mats, paper, or other protective material should be used

to protect the cargo from moisture running down the ladders, frames, stanchions, etc. When bagged cargo is loaded aboard a vessel on which no dunnage is used between the bags and the wooden cargo battens, the bags in the wings should be stowed on end to prevent them from protruding over the battens and coming in contact with moist metal and hull platings.

b. Bags should not be allowed to overlap the stringer plates of beams or similar obstructions in the hold because the motion of the vessel could cut the bags. Vertical dunnage against ladders and hatch battens will normally protect the bags from falling or chafing. Hand hooks should never be used to handle paper-bagged cargo.

(1) Bagged cargo in large lots is stowed in tiers across the hold. There are three general methods for stowing bagged cargo:

(a) The full-bag method (fig 6-15) provides good ventilation.

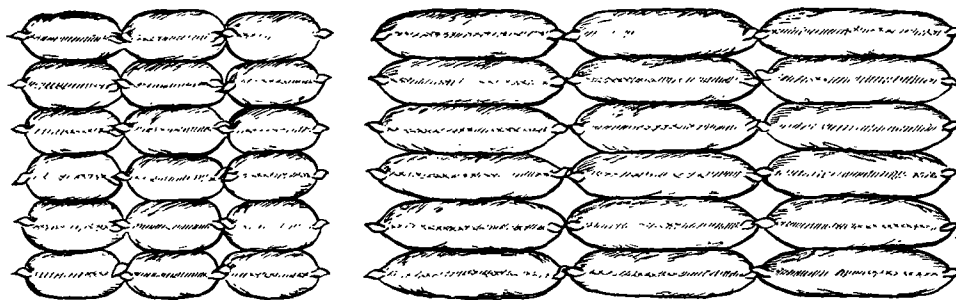


Figure 6-15. Full-bag stowage.

(b) The half-bag method (fig 6-16) is used where floor ventilation is not important and bags are soft.



Figure 6-16. Half-bag stowage.

(c) The cross-tier method (fig 6-17) is used at corners and at outer rows to prevent collapsing.

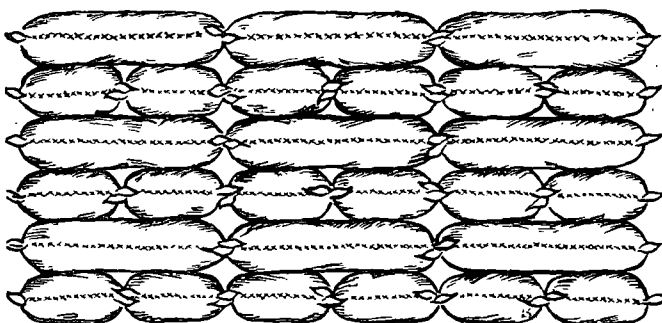


Figure 6-17. Cross-tier stowage

(2) Figure 6-18 illustrates a typical stowage of bagged cargo. Dunnage around the ladder protects the bags; the bulkhead prevents shifting; and the cross-tier method of stowing prevents collapsing.

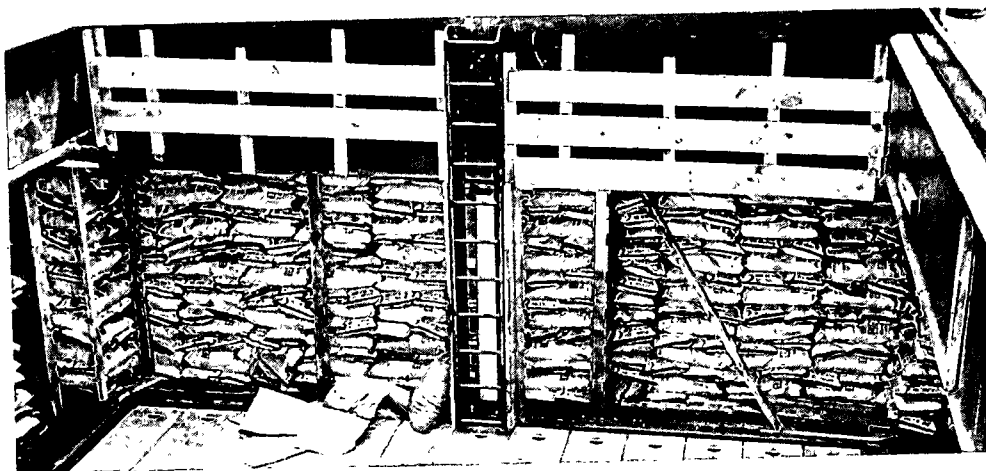


Figure 6-18. Typical stowage of bagged cargo.

6-10. Baled Cargo

a. Baled cargo is easily damaged by chafing. It should be carefully dunnaged and blocked off to prevent the cargo from moving. Flatboard dunnage should be used underneath bales since dunnage with sharp edges would cut through the bale wrappings.

b. Baled cargo should also be protected against damage from moisture.

(1) All metal parts in the hold should be dunnaged to prevent damage from moisture.

(2) Bales stowed in the wings of the hold are frequently placed on end so that only the outside layers of cargo will be damaged should moisture condense on the sides of the ship or should chafing damage the bale.

c. Bales may be stained by oil left on decks or overheads or by leakage from cargo stowed on upper decks.

6-11. Cardboard Cartons

a. Overstowed cardboard cartons are placed in the hold so that each one rests on two cartons below it. A level floor must be maintained. As the stowage proceeds outboard in the lower holds, care must be taken not to stow a carton in such a manner that it overhangs the tank tops. A row of cartons should not be stowed where the next carton, when placed in position, would rise above the level of the rest of the tier. Dunnage should be used to level the top tier before the next tier is stowed. This procedure should be used in the wings until the top of the stowed cargo is above the curvature of the hull.

b. Dunnaging between tiers of cardboard cartons is very important in distributing the weight properly, but it is not necessary to dunnage after each tier. In holds where cartons

are to be stowed to a considerable height, a floor of dunnage should be laid after the third tier of cartons, followed by another floor of dunnage after three more tiers, a third floor of dunnage after five or six more tiers, and a fourth floor of dunnage after five or six more tiers. No more than four floors of dunnage should be necessary. The first two floors are most important.

c. If necessary, vertical dunnage may be used to prevent cartons from becoming lodged in the sweat battens.

6-12. Cases

a. Strong wooden cases of uniform size may be stowed brick fashion in the same way as cardboard cartons without dunnage floors between tiers in the bottom of lower holds.

b. Lightly constructed cases of uniform size are stowed in the same manner as cardboard cartons.

c. If the cargo consists of items of variable sizes, additional precautions must be taken:

(1) Heavier cases should be stowed in the lower tiers.

(2) A case should never be stowed so that it rests directly on top of and inside the four corners of the case beneath is unless dunnage is laid across the top of the lower case to take the weight.

(3) Cases containing cargo that might leak should be stowed separately or at the bottom of the hold.

(4) Every effort should be made to keep tiers level. This can often be achieved by filling up the spaces between large cases with smaller cases.

(5) Lightly constructed cases should be dunnaged over before the next tier is started.

6-13. Crates

a. Crates are lightly constructed containers that are built as a framework with open sides and tops. Crates of this type are constructed for ocean shipping and are stiffened by the use of diagonal pieces of lumber. The bottoms are solid with well-built foundations that support their internal weight.

b. When crates are stowed, tiers should be kept level by laying dunnage between tiers. The dunnage may be spaced about 4 inches apart.

c. Crates should be stowed in the 'tween decks or in the top tiers of the lower holds. If it is necessary to stow cargo over crates, only lightweight cargo should be used.

6-14. Drums

a. *General.* Drums are usually made of steel. They are stowed athwartship, upright with the bungs up.

b. *Preparation of the Hold.*

(1) Lay dunnage approximately 6 inches apart on the deck and place drums on the dunnage.

(2) Build a shelf over the turn of the bilge (fig 6-19) or use cordwood for cribbing (fig 6-20).

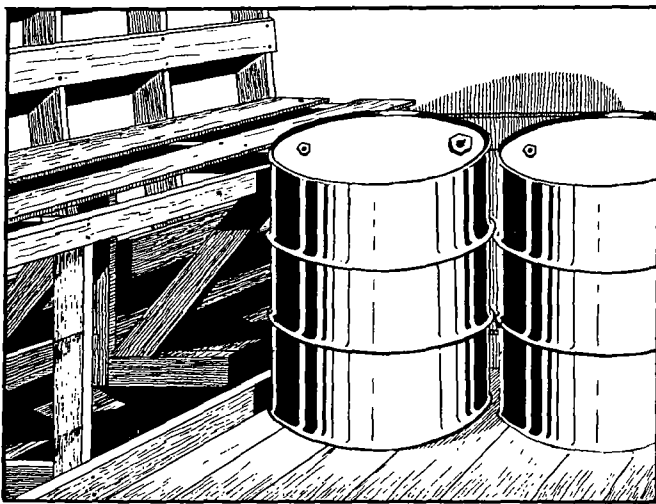


Figure 6-19. A shelf over the turn of the bilge.

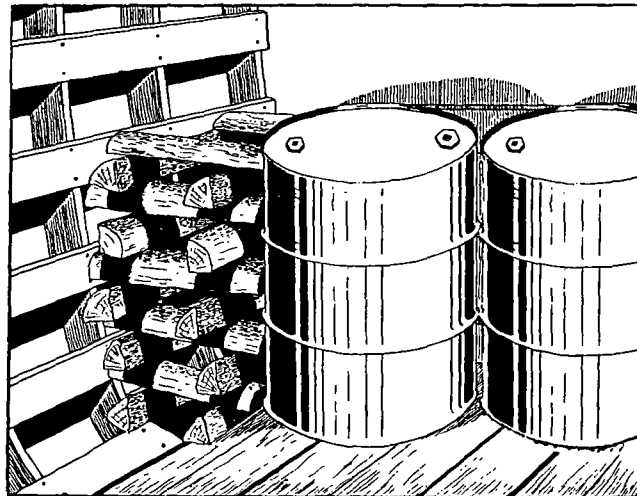


Figure 6-20. Cribbing at the turn of the bilge.

(3) Place dunnage between the first row of drums and the bulkhead.

c. *Stowing First Tier.*

(1) Work from wings to center of hold.

(2) Rest chimes squarely on the dunnage.

(3) If the first row does not fit securely across the bulkhead, save space by spreading out the drums equidistantly and staggering the next row of drums (keeping the same spacing as in the first row) so that they fit into the recessed areas created by the slight spacing between the drums in the first row.

d. *Stowing Second Tier.*

(1) Lay dunnage over the first tier.

(2) Place drums on dunnage, as shown in figure 6-21.

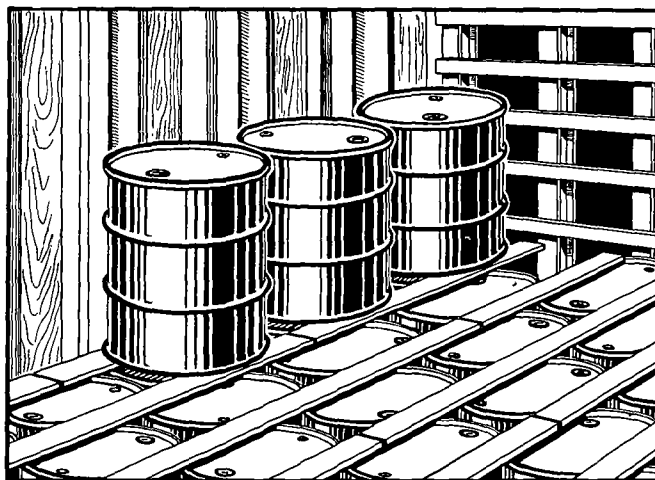


Figure 6-21. Use of dunnage in stowing drums.

(3) Stow succeeding tiers in the same way.

6-15. Cylinders

Strong steel cylinders are used for the shipment of compressed gases. These containers are under pressure of up to 2,000 pounds or more per square inch. They must be handled carefully and stowed securely to prevent damage to the cylinder which may cause additional damage to other cargo, as well as to the ship.

a. Equipment used for loading or unloading compressed gases must be adequate to prevent cylinders from falling during handling operations. Such equipment may be a tray with sideboards of sufficient height to prevent cylinders from falling off, a tray with small mesh net, a pallet with cylinders secured in place, or a bridle sling with a round twin at each end of the load.

b. Stowed instructions for each specific type of compressed gas are contained in paragraph 146.24-100 of the Code of Federal Regulations (CFR).

c. When CRF paragraph 146.24-100 permits ondeck stowage, cylinders must be properly stowed in a manner satisfactory to the master of the vessel, consistent with the following conditions:

(1) The vessel must have open spaces on deck suitable for such stowage.

(2) Sufficient structural protection must be provided by the vessel's freeboards or bulwarks.

(3) Cylinders must be stowed on their sides unless boxes, cribs, or racks are provided for vertical stowage.

(4) Cylinders must not be carried on deck over holds containing coal.

(5) When stowed "on deck protected," the cylinders must be protected from the direct rays of the sun by erecting awnings or other protective structures. Tarpaulins covering cylinders and in contact with them are not considered adequate protection. Use of wood dunnage is permitted for protection.

d. Cylinders stowed under deck must be stowed in cool compartments or holds either capable of being ventilated or of gastight construction, protected from open flame and any source of artificial heat, clear of living spaces for crew and passenger, and readily accessible from hatches or cargo holds.

e. Cylinders of compressed gas stowed either on deck or under deck onboard vessels will be kept from direct contact with the vessel's sides or bulwarks by dunnage, shoring, or other effective means.

f. Cylinders of compressed gas stowed on their

sides must be dunnaged under the first tier so that they will not rest directly on a steel or iron deck. Each additional tier must be stowed in the cantlines of the lower tier and in no case may cylinders be stowed bilge-to-bilge or directly on top of one another. The tiers may be stepped back and the ends of the cylinders alternated in order to clear the flange. Suitable lashing must be provided to prevent movement in any direction.

g. When cylinders are stowed in a vertical position, they must be stowed in a block and cribbed or boxed in with suitable sound lumber. The box or crib must be dunnaged at least 4 inches off the steel or iron deck. The cylinders in the box or crib should be braced to prevent any movement. The box or crib should be securely choked and lashed to prevent movement in any direction.

h. Lashing in all cases must be secured to pad eyes or other structural parts of the vessel. Pipe rails should not be used to secure lashings.

i. The valves of cylinders are protected by screw caps recessed into the cylinder. When cylinders are being handled, these screw caps must be on and the valves protected as much as possible. Rough handling may cause a valve to break and result in a serious accident; the uncontrolled escape of compressed gas will cause the cylinder to take off in flight, sometimes with enough force to blow it through the side of a ship.

j. Open flame lights and smoking are prohibited in the vicinity of deck cargoes of flammable compressed gases. "No Smoking" signs must be posted in the vicinity of such gases. Flammable gases may not be stowed below deck or on a vessel with class A or class B explosives, unless separated from the explosives by the engine or boilerroom spaces or bridge structure.

k. A leaking cylinder or other container of compressed gas must not be accepted for transportation.

6-16. Lumber

a. Lumber is shipped in loose board lots and packaged lots. Careful planning will reduce lost space in handling packaged lumber. Large voids can be filled in with loose boards as necessary. Lumber may be stowed on deck or below deck. Deckloads of lumber must be securely lashed. The use of 3/4-inch chain made fast to pad eyes on deck and secured with turnbuckles, pear links, and slip hooks on top of the cargo is a suitable method of lashing. Chain lashings should be spaced no more than 10 feet apart.

b. When finished lumber is being loaded, manila rope slings should be used for hoisting.

Hooks should never be used on finished lumber. If it is necessary to use bars to stow lumber, dunnage should be placed between the bars and the lumber.

c. When hoisting lumber, two slings should always be used. If only one is used, the boards on the inside of the load may slip out, damaging cargo and injuring personnel.

d. Lumber may be unitized for easier handling by making up drafts of uniform size and banding the cargo so that each draft can be handled as a unit.

6-17. Steel Plate

a. Steel plate should be bottom stowed in the lower holds or the 'tween decks. It should be stowed level on dunnage so that the weight of cargo loaded on top of it will be evenly distributed over the entire plate. Steel plate should be stowed in a fore-and-aft direction if possible.

b. The handling of steel plate is a difficult and dangerous operation. The following safety precautions should be strictly enforced when this type of cargo is being handled:

(1) Only use plate-handling clamps to lift steel plates high enough to land the plates on dunnage where they can be properly slung with wire rope slings. Never use plate-handling clamps for hoisting steel plate into or out of a hold.

(2) Sling steel plate on the quarters; i.e., at a point about one-quarter of the length of the plates from each end.

(3) If long lengths of plate have a tendency to bend when slung, use a round turn on each sling and use taglines to control the draft.

(4) Use crowbars or pinchbars for moving the plates into the final stowed position.

Section III. STOWAGE OF HEAVY LIFTS

6-18. General

a. Before heavy lifts are loaded, the holds should be prepared to receive the cargo. Dunnage, material for securing the lifts, blocks, shackles, draglines, bars, and other necessary equipment should be assembled beforehand and loaded into the hold before the first lift is hoisted aboard. When large numbers of heavy vehicles are being loaded, it is often possible to place the blocking and bracing material in the vehicles and hoist it aboard with the vehicles.

b. Before a heavy lift is picked up, all gear should be checked as described in paragraph 3-25.

c. Taglines should be used on all heavy lifts.

d. All personnel must stand well clear of a heavy lift coming into the hatch until it is lowered to within a few inches of the deck. Personnel can then assist in steadying the lift for landing.

6-19. Draglines

a. Draglines are set up on the holds and 'tween decks to drag heavy lifts from the square of the hatch to the place of stowage or from the place of stowage to the square of the hatch. These are long lengths of wire rope (approximately 60 feet) with an eye in each end. The dragline is rigged in the following manner:

(1) Attach a snatch block to the side of the vessel or to the bulkhead at each end of the hatch beyond the desired stowage location and in line with it.

(2) Attach a second snatch block to a stanchion or other fitting to provide a fairlead to the square of the hatch.

(3) Attach one end of the dragline to the item to be stowed. Pass the line through the snatch block that is made fast in the direction of stowage and then pass it through the fairlead block at the square of the hatch, attaching the other end to the cargo fall (fig 6-22).

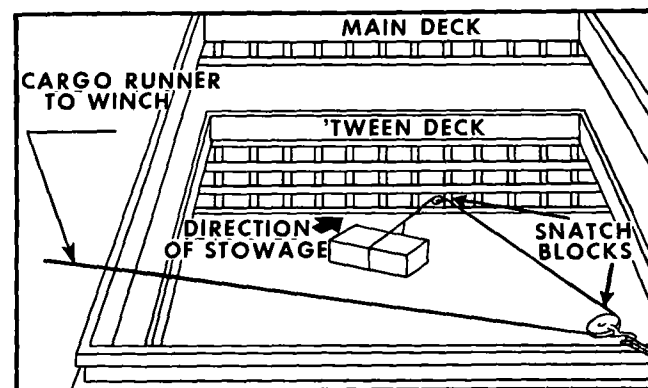


Figure 6-22. Fairleading a dragline.

(4) Drag the lift to its stowage position by taking up on the cargo runner with the winch. It is often necessary to drag one end of a lift to the place of stowage and then shift the snatch block to another position to drag the other end. An additional snatch block can be hung in the second

position before the dragline operation starts. A second block will speed up the operation considerably.

b. Many vessels have special runners that are used for dragline operations, but it is often necessary to use the regular cargo runners. If it is necessary to use them, take them off the boom. When cargo runners are used, the following precautions should be taken:

(1) Always strip the cargo runner from the boom and lead it from the winch to the heelblock and then to the hold.

(2) Always use a fairlead snatch block at the top of the hatch inside the coaming.

(3) Never run the cargo runner under the coaming; lengthen the dragline if necessary.

c. Whenever dragline operations are in progress, the following precautions should be taken:

(1) The dragline must be clear and must not rub or chafe at any point. Additional snatch blocks can be used to provide fairleads.

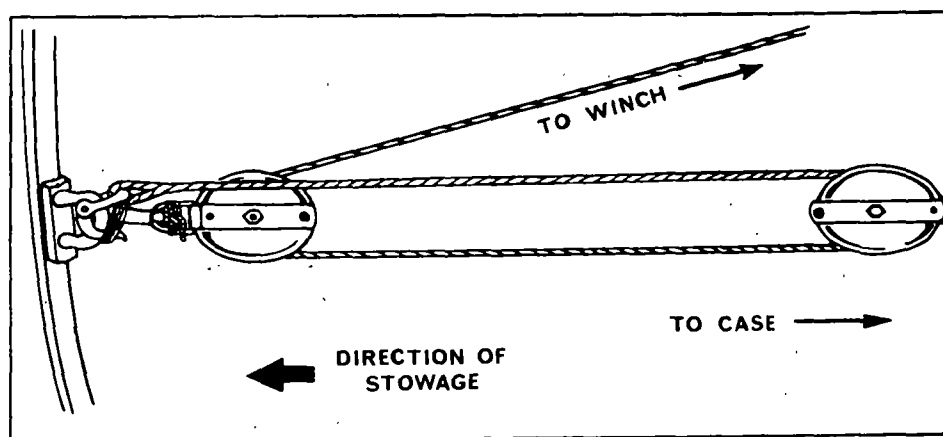
(2) When loading heavy lifts with the jumbo boom, lead runners to power at an adjacent hatch, warping winch, or anchor windlass. Do not drag with the cargo hook unless there is no other means to apply power to the dragline.

(3) If the lift is too heavy for the winch to pull, use a tackle (A, fig 6-23). If necessary, improvise a tackle using additional snatch blocks.

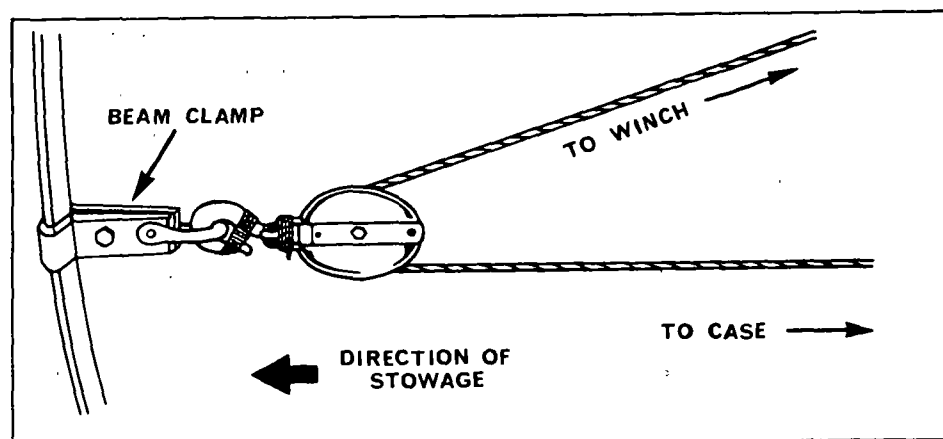
(4) Beam clamps may be made fast to stiffeners or frames for securing snatch blocks when no pad eyes are available (B, fig 6-23).

(5) Never pull on the side of a pad eye.

(6) Keep men out of the bight of the line at all times.



A



B

Figure 6-23. Use of tackle and beam clamps.

6-20. Large Heavy Cases

a. The main problem in stowing large heavy cases is moving them from the square of the hatch to the place of stowage. This can be accomplished by several methods:

(1) A case can be landed on rollers so that it is heading in the direction of stowage. The sling on the side next to the coaming is removed and, by topping, lowering, or swinging the booms, the head of the boom is moved in the direction of stowage. At the same time, a strain is taken on the sling still attached to the case. The case will move in the desired direction until the sling or cargo block is stopped by the coaming. Rollers are normally removed before the case is placed in the final stowage location. If further movement is necessary, a dragline may be used.

(2) Well-constructed cases weighing up to 7 or 8 tons may be landed on rollers and moved into position with crowbars and pinchbars.

(3) Cases may be landed on dunnage runways on which skid compound, soap, or grease has been smeared. The cases are then snaked into position with the dragline.

b. To prevent damage to cargo and injury to personnel, the following rules should be enforced:

(1) When slings are placed around heavy cases for dragging, dunnage should be placed between the case and the bearing part of the sling to prevent damage to the case.

(2) The case must be closely observed while it is being dragged into position to insure that it does not become jammed against dunnage, deck fittings, or other cargo. Any attempt to drag the lift while it is jammed will place an additional strain on the gear, and it may carry away the dragging sling or pull it through the side of the case.

(3) All men must keep out of the area between the lift being dragged and the place of stowage.

6-21. Wheeled Vehicles

a. Wheeled vehicles are hoisted aboard ship

with vehicle bridles and slings. They are landed in the hold so that they are headed in the direction of stowage. One man releases the brake and steers the vehicle while it is pushed into stowage position. If the vehicle cannot be pushed into position by hand, a dragline may be set up, or, in large hatches, a dock tractor may be used.

b. If it is necessary to move one end of the vehicle sideways to stow it in the desired spot, this can be accomplished by either of the following methods:

(1) Dunnage that has been smeared with skid compound or grease can be placed under the wheels on the end of the vehicle to be moved. Dunnage should be laid in the direction of the move. A dragline is set up and the ends of the vehicle dragged to the desired stowage spot.

(2) If heavy-duty rolling jacks are available, they may be used to move the end over.

c. Vehicles should be stowed fore and aft whenever possible. When it is necessary to stow them athwartship, permission should be obtained from the vessel's master or his representative. Special precautions must be taken when securing vehicles stowed athwartship.

d. The best method for securing any vehicle depends on the type of vehicle and its stowage location. The following procedure will serve as a guide (fig 6-24):

(1) Set the brakes of the vehicle.

(2) Block the vehicle at both sides and at both ends so that it cannot move in any direction. The size and type of vehicle will dictate the size of timber to use.

(3) Brace individual vehicles to bulkheads, stanchions, or other vehicle blocking.

(4) If lashing is required in addition to blocking and bracing, lash vehicles with wire rope. Block under bumpers or chassis to keep tension off the springs.

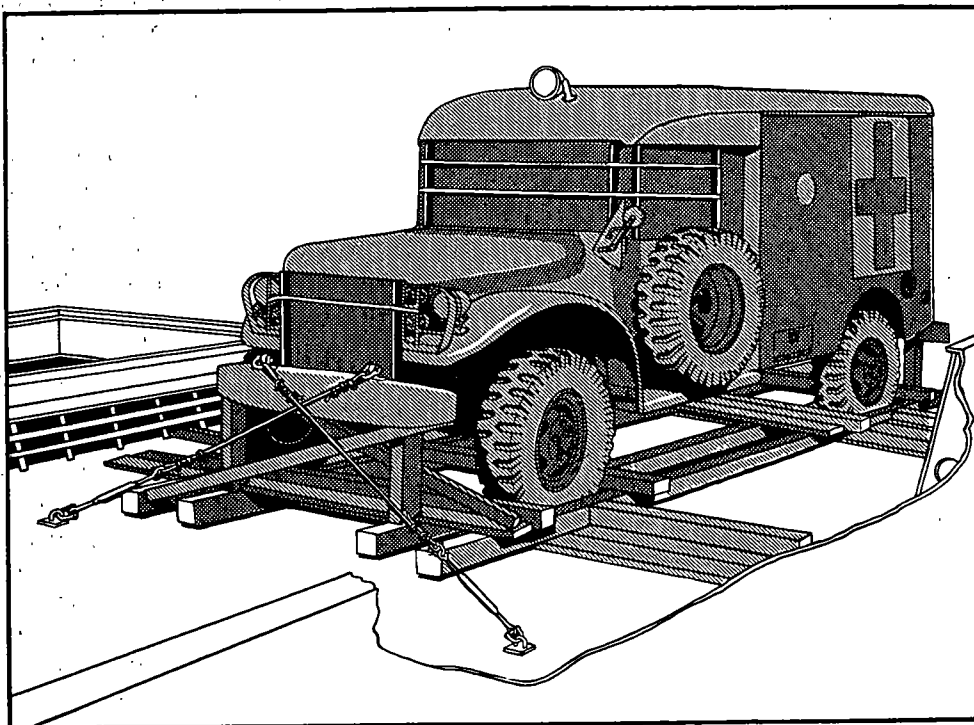


Figure 6-24. Vehicle secured on deck.

6-22. Tracked Vehicles

a. Tanks, crawler cranes, and bulldozers are moved from the square of the hatch to their stowage position by draglines. Movement can be facilitated by braking or releasing the tracks of the vehicle as required to control the direction. Only experienced operators of heavy equipment should be permitted to steer tracked vehicles.

b. Tracked vehicles must be stowed in a fore-and-aft position. They must be left in gear with the brakes on. Turrets on tanks and cabs on cranes must be locked or lashed in position.

c. A solid floor of planking not less than 2 inches thick must be constructed before tanks, bulldozers, or cranes are loaded on top of cargo such as steel plate or slabs of metal. The floor must be nailed down. When tanks are stowed in the 'tween deck, similar floor should be laid.

d. Tracked vehicles weighing less than 18 tons should be secured by at least 4- by 6-inch lumber, and those weighing more than 18 tons should be secured by at least 6- by 8-inch lumber (fig 6-11). All tracked vehicles, whether stowed on deck or below deck, should be lashed with wire rope or chain.

6-23. Stowage of Piling (Creosote Logs)

a. Piling is usually stowed on deck, but it may sometimes be necessary to stow it below deck. Piling stowed below deck is usually placed in the larger hatches. The following precautions should be taken when handling piling:

(1) Always use two slings when hoisting piling. Each sling should have a safe working capacity capable of supporting the load by itself.

(2) Always use taglines when handling piling.

(3) The creosote on piling will burn the skin and eyes. When handling piling, do not touch face or eyes with the hands. After piling has been handled, wash hands, face, and gloves thoroughly with soap and water.

b. Piling over 60 feet long is usually stowed on deck. It may sometimes be necessary to change the position of the slings in order to place the piling in the stowed position. A dragline can be rigged for pulling the piling into position. It may be necessary to use the gear at the next hatch to stow extremely long piling.

Section IV. STOWAGE OF REFRIGERATED CARGO

6-24. General

Stowage of refrigerated cargo does not differ greatly from that of general cargo, except that refrigerated cargo requires more care with temperature and ventilation and normally is not palletized. Foods having a strong odor should not be mixed with those having a tendency to absorb odors. All cargo compartments must be at the prescribed temperature before loading to prevent refrigerated cargo from thawing or spoiling.

6-25. Types of Refrigerated Cargo

Perishable cargo is divided into three general classes—frozen, chilled, and air-cooled cargo.

a. Frozen Cargo. Frozen cargo is transported at temperatures ranging from 0° to 32° F. Meat, fish, butter, and poultry are classified as frozen cargo.

(1) Quarters of beef are shipped at temperatures of 12° to 15° F. They are usually wrapped in Hessian cloth and stowed fore and aft on edge. If stowed flat, air circulation is impeded. Forequarters and hindquarters of beef cannot be stowed well together; usually they are stowed at different ends of a compartment. Beef quarters may be stowed as high as personnel can reach. Those stowed in the center of the hatch should be covered with clean canvas. Dunnage should be laid for stevedores to walk on and land cargo on. If the quarters of beef are overstowed with cargo, 3- by 3-inch battens should be placed on the beef. If the battens are not frozen before use, the meat will become marked. In a hold completely filled with beef, battens are not necessary as the irregular shape of the beef quarters permits circulation of air.

(2) Fish is shipped hard frozen in cartons at 20° F or lower. It should be stowed in a separate hold to avoid trainting other food. Cases should be stowed fore and aft on athwartship battens spaced to support the cases.

(3) Butter, which is usually shipped in cartons, may be stowed with meat, but should not be stowed with fruit as it will absorb odors from fruit. Butter is hard-frozen cargo and can be carried at 20° F or lower. The loading temperature should never be higher than 30° F. Battens must be used to separate the cartons and permit circulation of air.

(4) Mutton and lamb carcasses are shipped hard frozen at temperatures ranging from 10° to 15° F. Canvas slings should be used for handling. This cargo is brittle and should be handled carefully. To permit circulation of air, 3- by 3-inch

frozen battens should be used. Since this cargo is light it should not be overstowed with heavier items.

(5) Pork carcasses are shipped hard frozen at temperatures ranging from 10° to 15° F. Stowage is the same as for mutton.

(6) Poultry is shipped at temperatures of 20° F or lower.

b. Chilled Cargo. Chilled cargo is transported at temperatures ranging from 33° to approximately 60° F, depending on the commodity. Eggs and fresh vegetables are carried as chilled cargo.

(1) Cheese is usually transported in wooden cases at temperatures ranging from 35° to 40° F. Under certain conditions, cheese gives off noxious fumes which should be cleared before men are allowed to enter the compartment. Cheese is also subject to taint.

(2) Fresh vegetables and fruits are carried at temperatures ranging from 34° to 40° F. This cargo is normally shipped in crates and should be stowed and dunnaged to permit the free circulation of air. The most important factor to consider when transporting fresh fruit is ventilation. A mechanical refrigeration system depends as much on the complete circulation of air as it does on refrigeration. It consists generally of intake and exhaust fans and air coolers throughout the hold. The air is cooled by the fans which keep it circulating through the cargo spaces.

(3) Cargo that is likely to taint other cargo or that readily absorbs the taint of other commodities must be kept in compartments with separate cooling systems.

c. Air-Cooled Cargo. Though mechanical refrigeration systems are more satisfactory, fresh vegetables and fruits can be carried without refrigeration on short voyages. If picked at the right time, they may be carried with only natural ventilation.

6-26. Loading Refrigerated Cargo

a. Of all the types of cargo loaded, refrigerated cargo is the most difficult to handle because of the high degree of spoilage resulting from rough handling, inclement weather, and delays in loading.

(1) Speed is essential in loading refrigerated cargo. Careful planning is necessary so that commodities will not remain out of refrigeration too long.

(2) Damage to the cargo resulting from

exposure to rain, handling that has caused bruising, or delays in loading that have caused temporary thawing may not be immediately apparent to the loading authorities. However, any damage will become apparent at destination and could result in the forced issue or destruction of the entire cargo.

(3) The selection of the cargo handling gear is important because most of the containers are of light construction to allow circulation of air and can be easily crushed.

(4) The use of hatch tents in inclement weather is suggested to prevent damage to cargo already stowed. Using hatch tents in the tropics during daytime operation will keep the temperatures of cargo compartments from rising too rapidly and will reduce the number of delays required to close the hatch.

b. Representatives of the port veterinarian must be present at all times during loading to inspect the condition of the cargo and the

correctness of the stowage and to monitor temperatures.

6-27. Inspection

After loading the hatch, an inspection of the stowage should be made by a ship's officer, a cargo loading officer, and a representative of the port veterinarian. The inspection should determine whether ample allowance has been made for the circulation of air and whether the cargo has been properly stowed.

6-28. Temperature

a. A record of temperature changes should be maintained during cargo operations. These records will help the loading personnel meet their responsibility for keeping the hold at the right temperature.

b. The master of the vessel must be informed of the temperature to be maintained throughout the voyage to insure the delivery of the cargo at destination without injury.

Section V. STOWAGE OF DANGEROUS CARGO

6-29. Regulations

a. Explosives constitute the majority of military cargo classified as dangerous and hazardous. However, dangerous and hazardous cargo includes combustible and flammable liquids and solids, corrosive liquids and acids, gases, and poisons. Operating personnel should be thoroughly familiar with the regulations dealing with these commodities before the cargo is worked. Title 46, Code of Federal Regulations, specifies that the loading and stowage of military explosives and other dangerous and hazardous cargo aboard merchant vessels falls under the jurisdiction of the US Coast Guard. US Coast Guard publication CG 108, Rules and Regulations for Military Explosives and Hazardous Munitions, contains the special requirements governing transportation of military explosives on board vessels. AR 55-228 stipulates that all such cargo of the US Army will be loaded and stowed in accordance with the regulations of CG 108 regardless of the type of ship or the geographical area involved. Key provisions of the regulations are—

(1) The authority for enforcement of CG 108 is vested in the Coast Guard; however, in the case of Army or Air Force cargo, the Ordnance Corps will provide an inspector to give advice on the safe handling and stowage of explosives. The Chemical Corps is responsible for inspecting the

loading and stowage of dangerous and toxic cargo. A Coast Guard inspector can be available for advice upon request. It is the responsibility of the cargo handling personnel to insure that the regulations of the Coast Guard, the Ordnance Corps, and the Chemical Corps are complied with.

(2) The loading terminal must submit a prestowage plan for approval and a written request to the US Coast Guard captain of the port for permission to load dangerous or hazardous cargo. The loading pier or anchorage area must be specified.

b. Since many of the propellants used in modern missile systems are composed of chemicals not in general use, no legal rules and regulations for moving them have been published. Special request must be made to the Coast Guard for information on how to move such materials. Technically qualified personnel must be present to advise on safe handling.

6-30. Labeling Dangerous and Hazardous Cargo

a. Each item of dangerous or hazardous cargo must be appropriately identified by one of the newly established international shipping labels. The new labels are of a standard size, shape, and color and bear an easily recognizable symbol that indicates the content of the container.

b. Except for the rectangular shaped "Biomedical Material" label, the labels are 4- by

4-inch diamond-shaped labels with black lettering on the following backgrounds:

- (1) Orange—explosives (A, B, and C).
- (2) Red—flammable liquid or gas.
- (3) Green—nonflammable gas.
- (4) Yellow—oxidizer or organic peroxide.
- (5) White—poison or poison gas.
- (6) White or white and yellow with either one, two, or three red vertical classification bars—radioactive material.

(7) Red and white vertical stripes—flammable solid.

(8) White lettering on black background and black symbol on white background—corrosive.

6-31. Bombs

a. Nearly all bombs are now palletized. Once they are placed inside the hold of a ship (fig 6-25), they should be handled with electric forklift trucks for safety reasons (fig 6-26).



Figure 6-25. Setting down pallets of 750-pound bombs in hold of ship.

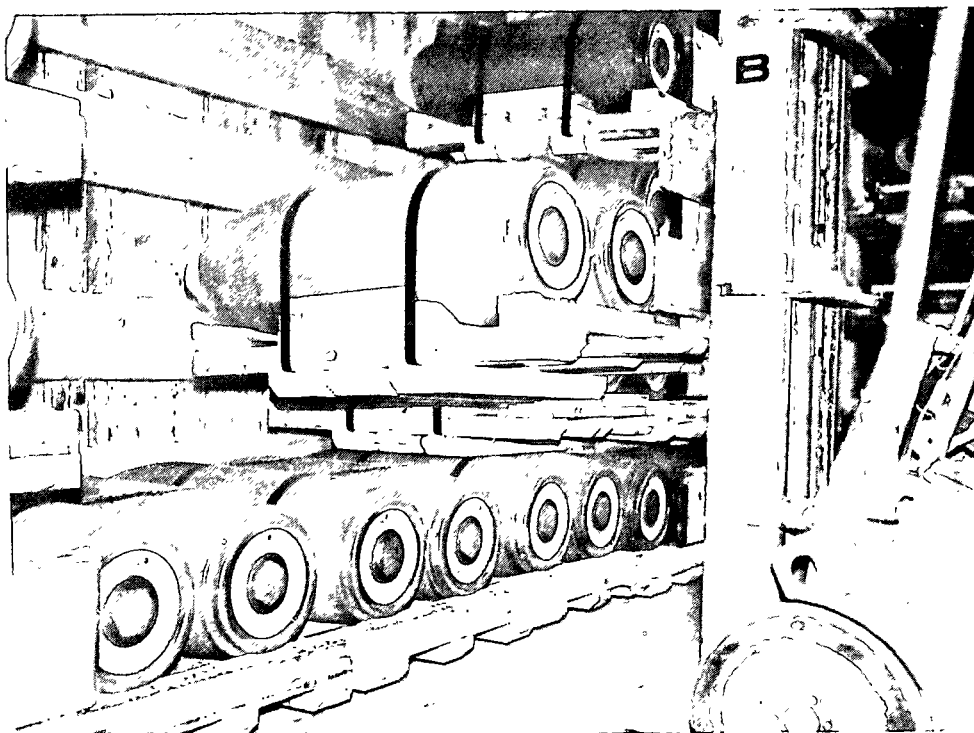


Figure 6-26. Stowing bombs with electric forklift.

b. Stowage of bombs within a hold must include proper tomming, bracing, and use of separation boards between rows of pallets. In figure 6-27, a 2- by 4-inch board extends downward at a 45° angle in the top of the picture (tomming), 4- by 4-inch and 2- by 4-inch boards provide support in the open space where the carpenter is standing between rows (blocking and bracing), and separation boards (dunnage) have

been placed between the heads of one row of bombs and the tails of another row of bombs in the lower right-hand corner of the picture. This head-to-tail configuration is the best one for the stowage of bombs, as it results in better space utilization and less carpentry in securing. While tail-to-tail stowage of bombs is acceptable, it results in loss of space and requires more extensive securing between the heads of bombs.

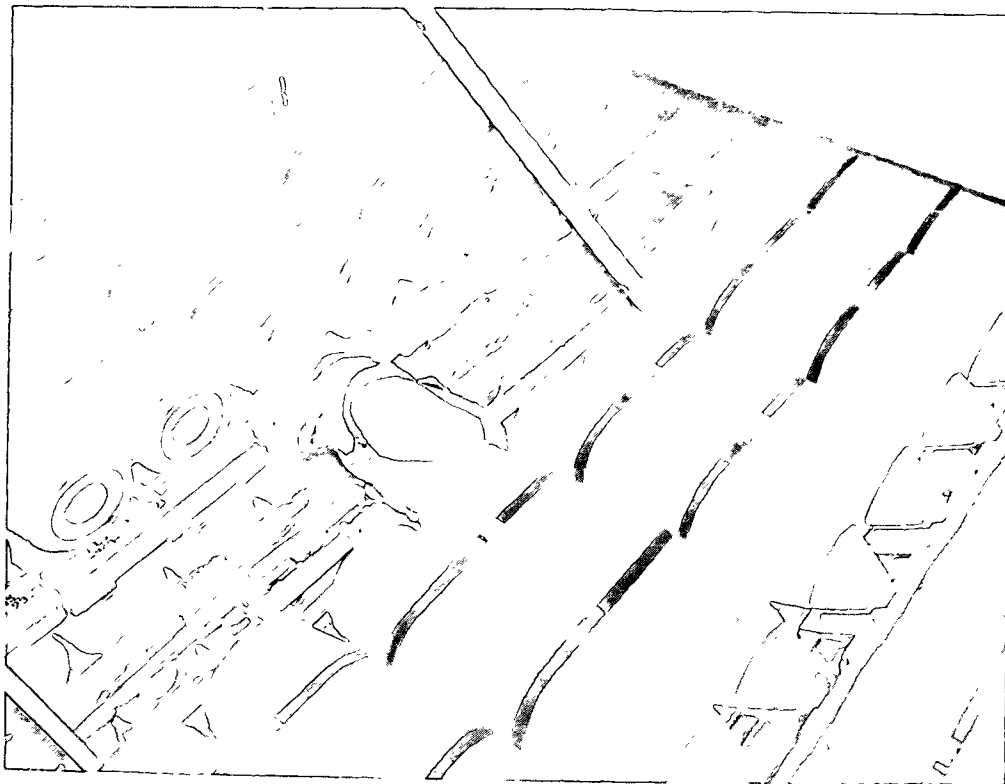


Figure 6-27. Properly stowed 750-pound bombs.

c. Proper bracing must also be provided in those areas where bombs are stowed near the bulkheads (fig 6-28) or the sides (fig 6-29) of the

ship. The four-tier-high bombs in figure 6-30 show that similar precautions should be taken around the hatch ladder and stanchion.

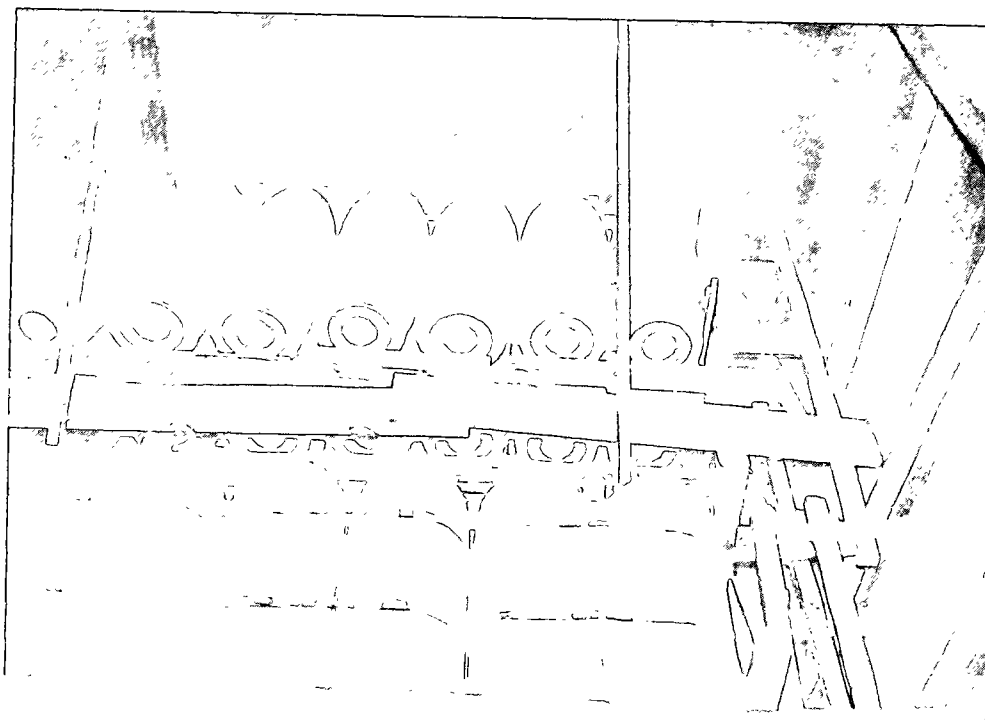


Figure 6-28. Proper bracing of bombs near bulkheads.



Figure 6-29. Proper bracing of bombs near side of ship.

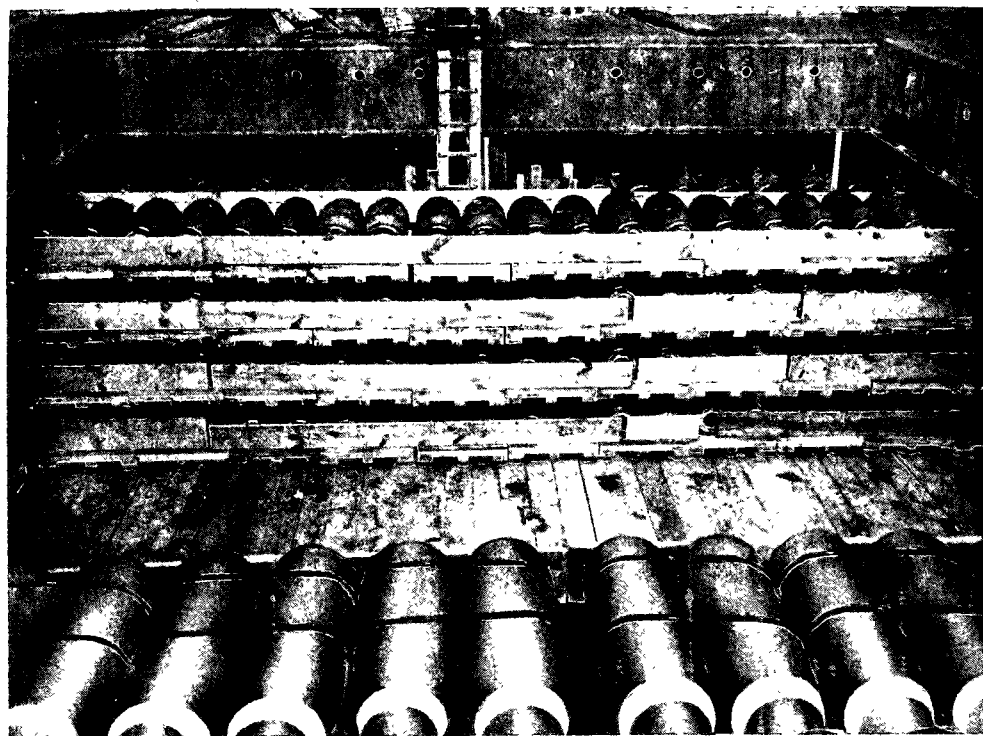


Figure 6-30. Proper bracing of bombs near stanchion and hatch ladder, four tiers high.

d. Boards used for all of the above operations should be at least 2 inches thick, though they may be any width.

e. Bombs weighing 2,000 pounds are individually stowed. There are three basic methods of individually stowing these bombs.

(1) *First method.*

(a) Place two 4- by 4-inch timbers athwartship in the hold to form tracks on which the bombs can rest. These timbers keep the rolling bands free of the deck.

(b) Roll the bombs across the deck of dunnage and place them on the tracks, band to band (fig 6-31).

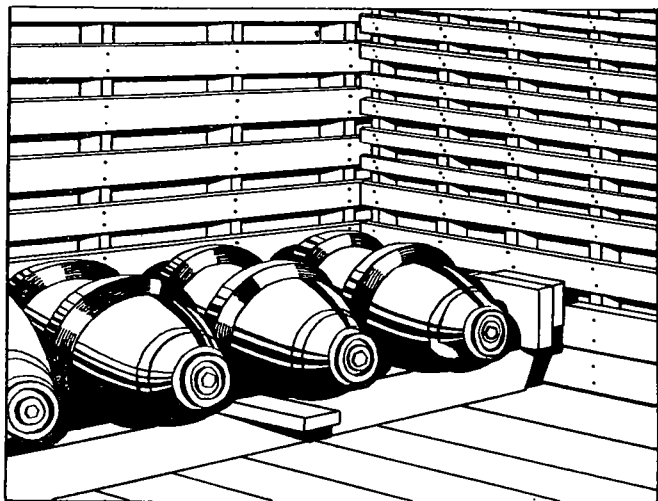


Figure 6-31. Stowing first row of bombs.

(c) Block and brace bombs securely to prevent movement.

(d) To protect the head and tail fins of the bombs, separate the second row from the first by dunnage as shown in figure 6-32.

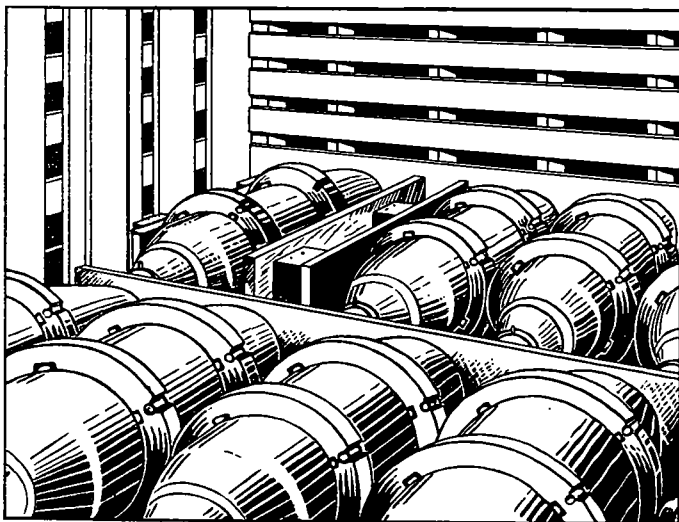


Figure 6-32. Dunnage used to separate bombs.

(e) To load succeeding tiers, prepare a track ((a) above) to use on top of the first row of bombs. No floor of dunnage is required between the tiers.

(f) Place the rolling bands of the second tier of bombs directly above those of the first (fig 6-33).

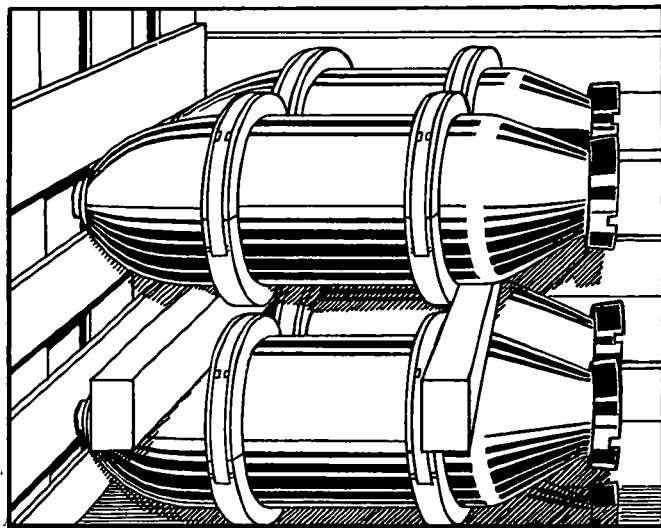


Figure 6-33. Band-to-band method of stowing bombs.

(2) *Second method.* No athwartship timbers are required in this method.

(a) Start the first row directly on the dunnage floor.

(b) Brace the bombs in the outboard row against the side of the hold.

(c) Place dunnage between rows to protect the head and tail fins.

(d) Lay 2- by 4-inch timbers athwartship to clear the rolling bands of the first tier.

(e) Lay a floor of dunnage over the athwartship timbers and continue the second tier in the same manner as the first.

(3) *Third method.* This method differs from the second method ((2) above) in that the rolling bands are interlocked and every other bomb is turned end for end so that the tail of one bomb is adjacent to the head of the adjoining bombs.

f. Although the methods described in e above deal only with fore and aft stowage, bombs may be stowed athwartship to fill in unused space (fig 6-34).

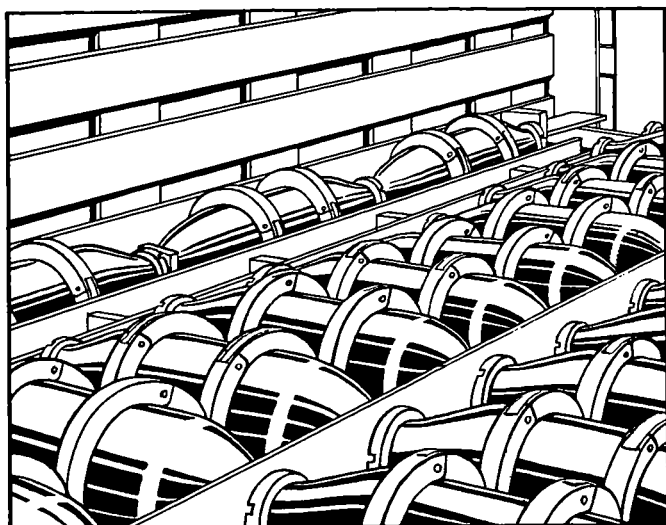


Figure 6-34. Athwartship stowage of bombs.

g. The last tier of bombs must be held in place by loading other compatible cargo on top or by tomming (fig 6-12).

h. Additional information on stowage and handling of bombs may be found in CG 108.

6-32. Missiles

The large assortment of different types of missile components within the inventory creates unusual problems for transportation terminals. Careful planning, special caution, and complete information regarding the characteristics of missile cargo is necessary to its safe, successful, and efficient handling.

a. Terminal Receipt of Cargo.

(1) Advance information must be obtained by cargo operations personnel concerning the size, weight, characteristics, packaging data, and peculiarities of the missile components which are to be handled. The depot originating the shipment may provide this information in written documents, photographs, and in conferences with representatives of organizations involved in the movement. Utilizing this information, the terminal prepares instructions governing the handling of the components for the guidance of terminal personnel and units that are concerned with the cargo.

(2) Upon receipt of missile components, a detailed inspection is made to determine their condition and whether the terminal should accept the shipment for export.

(3) Sometimes special protective clothing must be worn by personnel involved in the physical handling of missile propellants and oxidizers.

(4) Certain components are shipped in

special containers that have temperature, pressure, or humidity gages attached to them. These gages should be checked to insure they meet allowed tolerances given in the instructions from the terminal.

(5) All material received at the terminal in a damaged condition or in any condition other than that acceptable for export should be rejected and turned over to the technical-service representative for disposition.

b. Handling, Loading, and Storage.

(1) Special slings and lifting devices required for transferring and loading missile components at water terminals usually accompany the shipment. Standard materials-handling equipment and watercraft can handle missile components. With the improvements in missile container design and the incorporation of transportation features in the construction of components, the problems associated with shipping this type of cargo are diminishing. Nevertheless, careful planning and special caution will always be mandatory.

(2) Standard cargo-tiedown equipment, consisting of the usual bracing, shoring, lashing, and tomming, is fully effective in securing the missile components.

c. Temporary Storage of Missile Components.

(1) The storage area should be clean, level, and well drained. Some form of shelter should be provided if components are subject to weather or temperature limitations.

(2) Dangerous and hazardous components must be stored away from overhead powerlines and in areas free of combustible material.

(3) Cargo should be stacked as instructions specify.

(4) When used, dunnage must be the type specified in governing instructions.

(5) Activity in the storage area should be restricted to receiving, inspecting, and discharging cargo.

(6) Guards must be posted and signs displayed for dangerous, hazardous, or classified cargo.

(7) Frequent inspections should be made to determine condition of cargo. Gages on sealed containers must be checked periodically.

(8) Commodity distance tables must be complied with.

(9) Decontamination squads and firefighting teams must be readily available where special weapons are stored.

d. Cargo Discharge. Discharge problems with missiles are generally comparable to those of

loading. Because of the sensitivity of certain components of the missile systems, discharge of these items from a vessel at anchor to lighterage is highly inadvisable unless good sea and weather conditions exist. Hard impact occurring upon the landing of cargo into pitching or rolling craft

could render these sensitive items inoperative. Propellant fuels must also be handled with great care as the rupturing of, or shock to, the container could easily result in fire, explosion, or the release of penetrating, deadly vapors.

Section VI. STOWAGE OF PALLETIZED CARGO

6-33. Palletization Characteristics

Palletized unit loads are formed on general purpose four-way entry pallets. A palletized unit load may not be more than 52 inches long, 43 inches wide, and 54 inches high (including the pallet), and the gross weight may not exceed 3,000 pounds. Constructed to maximum size, the cargo may overhang the pallet 2 inches on each end and 1½ inches on each side; the palletized unit load will occupy approximately 70 cubic feet of shipping space. The cargo and pallet are securely bound together with adhesives and/or various types of banding. A common method is to use five steel straps around both cargo and pallet. Two are spaced equally and placed longitudinally, the three are spaced equally and placed transversely.

6-34. Stowage

When a small number of palletized loads are stowed, the best location is the square of the hatch. However, if the volume of palletized cargo is great, it must be stowed in the ends and wings. Unlike heavy lifts, pallets are not designed for dragging. Although pallets can be dragged into the wings and ends, dragging is time consuming and dangerous and causes excessive damage to the cargo. The following methods are recommended for placing palletized cargo in underdeck stowage:

a. If there is sufficient headroom for forklifts to maneuver, they may be used as follows to stow palletized cargo:

(1) Place the required dunnage in the hatch. Usually little dunnage will be necessary since the pallet itself serves as dunnage, but some dunnage may be needed for leveling off, padding obstructions, etc.

(2) Hoist a forklift into the hatch. Short-mast, pneumatic-tired forklifts should be used.

(3) Land the pallets in the hatch so that the access slots face in a direction requiring a minimum of forklift maneuvering. Using the forklift, engage the load and proceed to the place of final stowage.

(4) If pallets cannot be tiered underdeck because of insufficient headroom clearance, it is often possible to load one pallet on top of another in the square of the hatch and move both pallets into the final stowage position with the forklift.

(5) Use filler cargo or chocking to take out the sheer at the bottom of the hatch and to fill in any voids created by the shape of the cargo or stanchions or other fittings. Filler cargo must be a type that will not be easily damaged.

(6) If it is necessary to operate a forklift on top of unitized cargo, dunnage off the entire hatch with two layers of dunnage, one fore and aft and one athwartship, making the floors solid.

b. Though not now an authorized table of organization and equipment (TOE) item, pallet jacks may sometimes be justified, obtained, and used to move palletized cargo into final stowage position underdeck. Since pallet jacks cannot be used to tier cargo, it is necessary to stow one tier at a time. Dunnage must be laid between tiers so that the pallet jack can be maneuvered.

c. Palletized cargo may be moved into final stowage position by roller conveyors.

(1) With roller conveyors laid from the square of the hatch to the stowage position, the draft can be landed on the conveyors and rolled into position. Conveyor sections must be shifted after each draft.

(2) One section of roller conveyor can be inverted so that the rollers are next to the deck or dunnage. The conveyor is spotted so that it is pointing in the direction of stowage. The draft is landed on the inverted conveyor and rolled into stowage position. The draft must be lifted so that the conveyor can be removed. The truck dolly or pallet dolly may also be used in the same manner as the inverted roller conveyor.

d. Palletized cargo may be moved into final stowage position using wooden or metal single-type rollers.

Section VII. STOWAGE OF DECK CARGO

6-35. General

a. All combat and transport vehicles, equipment, and other cargo subject to damage by sea water should be stowed below deck unless—

(1) They are too large to go through the hatches.

(2) There is no room below deck and shipment cannot be delayed.

(3) The nature of the cargo is such that deck stowage is required by law and regulations or by

the generally recognized customs of the shipping trade.

b. Cargo loaded on deck should be protected as much as possible from damage by sea water. Proposed deckloads and methods of securing them must receive concurrence by the ship's master. No deckloads should be stowed without his permission. Strips of dunnage are laid on deck to receive cargo, facilitate removal of slings, and protect cargo from water on deck (fig. 6-35).

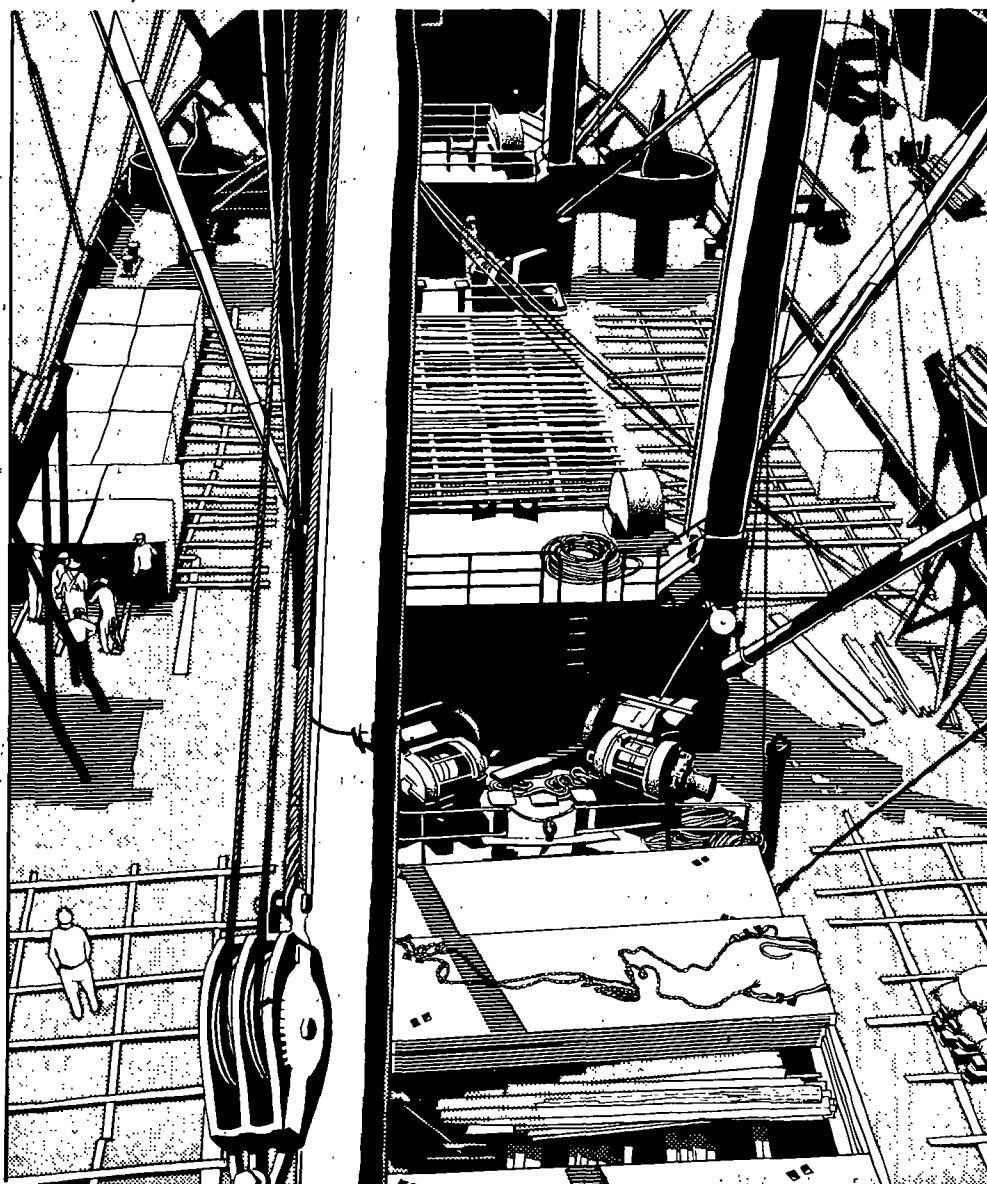


Figure 6-35. Use of dunnage strips to protect deck.

c. When a large quantity of cargo is to be stowed on deck, care must be taken to avoid blocking off equipment listed below. It is good

practice to outline in chalk the spaces to be kept clear.

(1) Bitts and chocks.

(2) Sounding pipes to the bilges and ballast tanks.

(3) Handles of valves controlling the operation of watertight bulkheads or piping systems.

(4) Any other items of equipment essential to the safe operation of a vessel.

6-36. Catwalks

For the safety of the crew, catwalks should be

constructed over deck cargo (fig 6-36). They should not be less than 3 feet wide and should have strong handrails and suitable approaches. Straight ladders to the well deck should be avoided. Ramps should be built so that the crew will have ready access to lifeboats, gun stations, and other frequented work areas.

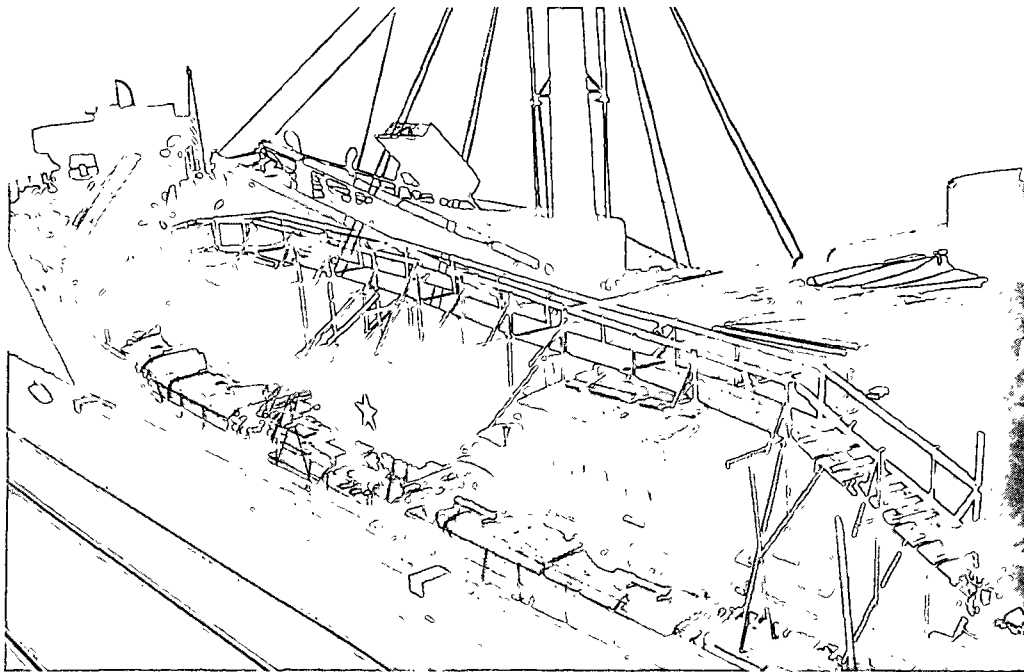


Figure 6-36. Catwalk over deck cargo.

6-37. Cases on Deck

a. Deck cargo should be stowed so that it can be lashed in three separate blocks: one on the square of the hatch and one on each side (fig 6-37). The following precautions should be observed when cargo is stowed on deck:

- (1) Lashings should be wire rope or chain.
- (2) Angle irons should be used on corners or edges under the lashing to prevent cutting into the case.
- (3) Exposed forward parts of the cases should be sheathed for protection against sea water.
- (4) It may sometimes be necessary to stow deck cargo on the square of the hatch in such a

manner that the cargo extends beyond the hatch coaming. Tables must be built to support the overhanging cargo beyond the square of the hatch.

(5) When cases are secured on deck, bracing is preferable to shoring since shoring has a lifting effect on cargo.

(6) Lag screws or bolts should be used to tie timbers together. Nails and spikes should be used only on small timbers or where it is impossible to use screws and bolts.

b. Additional information on lashing is included in paragraph 6-5.

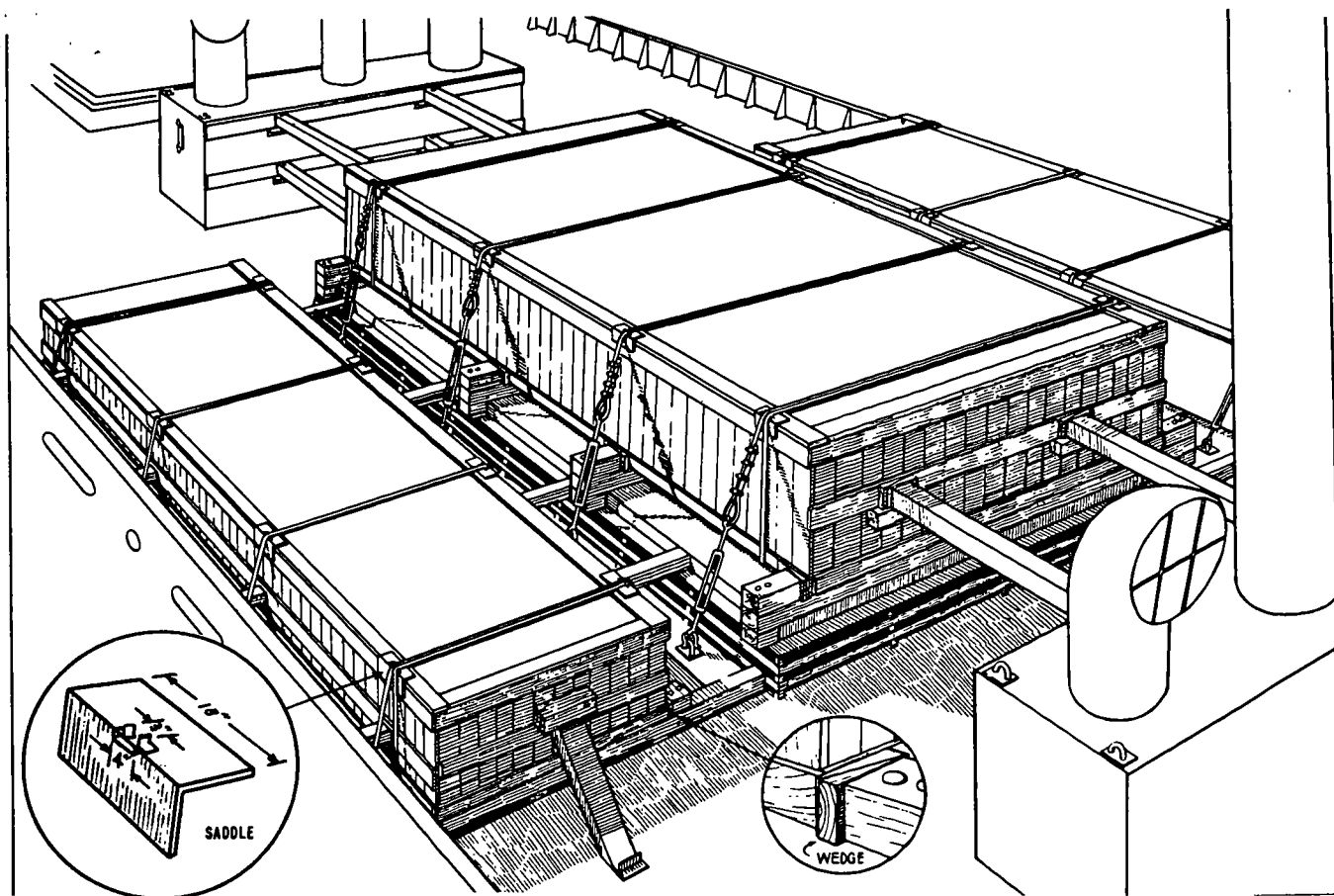


Figure 6-37. Cases secured on deck.

6-38. Wheeled Vehicles on Deck

- a. Vehicle engines should be facing forward.
- b. A double layer of 1-inch thick dunnage should be placed on deck under the wheels. Each vehicle should be blocked on both sides and at both ends so that it cannot move in either direction. Care must be taken to brace all wheel chocks. A minimum of two lashings are required on the front and two on the rear of vehicles such as trucks and ambulances; however, additional lashings may be required by the master of the

vessel. Lashings may be either crossed or led outboard from the vehicle.

- c. The chassis should be blocked up to take the pressure (caused by the tension of the lashing) off the springs (fig 6-24).

- d. Figure 6-38 illustrates deckloading of vehicles when mechanical quick-release devices are available as part of a ship's gear. When these devices are used, no special blocking and bracing or dunnage as detailed in *b* above is necessary.



Figure 6-38. Lashing of vehicles on deck using mechanical quick-release devices.

6-39. Tracked Vehicles on Deck

a. Tanks and other tracked vehicles when stowed on deck are secured as follows:

(1) Land vehicle treads on two 4- by 12-inch timbers.

(2) Secure an 8- by 12-inch timber against the treads on each side by three angle irons. Each angle iron should have holes for two 7/8-inch lag screws to be used to secure the 8- by 12-inch timbers to the deck.

(3) Chock each end of the vehicle with a timber placed against the treads and secured to the fore-and-aft timbers.

(4) Lash vehicles to the satisfaction of the vessel master. Tie rods, chain, or wire rope and turnbuckles may be used for this purpose.

b. The timber sizes given above are merely

guides. The proper material may not always be available in oversea areas.

6-40. Locomotives on Deck

a. Diesel-electric locomotives (fig 6-39) are among the largest and most difficult items that military cargo handlers will be required to handle. They must be loaded and discharged by experienced personnel and require special handling equipment. Assume that one of these locomotives has a wheelbase of 10 by 5 feet and weighs 90,000 pounds; this weight rests on an area of 50 square feet, resulting in a load of 1,800 pounds per square foot. Since the deck of the average vessel will not support more than 300 to 400 pounds per square foot, the 'tween decks and the lower holds must be shored.

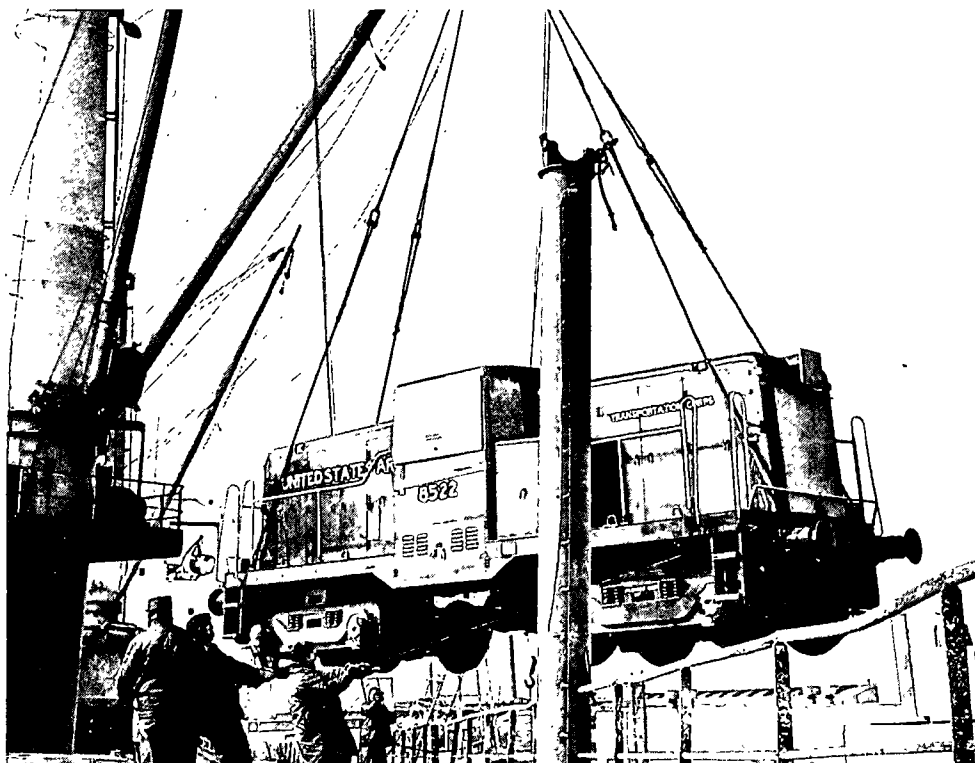


Figure 6-39. Hoisting a locomotive.

b. In order to spread the weight as effectively as possible, the wheels of the locomotive must rest on sleepers on deck. Sleepers are 6- by 12-inch timbers, 40 feet long. Balk timbers 12 by 12 inches and 40 feet long are placed on the outside of the sleepers and are secured by angle irons. Spreaders are used between sleepers and balk timbers and are secured by four tie rods of at least 1-inch rod iron, threaded 4 inches on each end to take a stud nut and washer. Spreaders are not secured to the fore-and-aft stringers but act as spacers and are held by the clamping action of the rods.

c. The 'tween decks and lower holds are shored with at least 12- by 12-inch timber. If 12- by 12-inch timber is not available, 8- by 8-inch or 10- by 10-inch timber may be substituted, but additional shoring will be required. The shoring must be placed in two rows under the sleepers, directly beneath the deck frames, with timber braces placed under the deck and between the deck beams to assist in evenly distributing the weight of the locomotive (fig. 6-40).

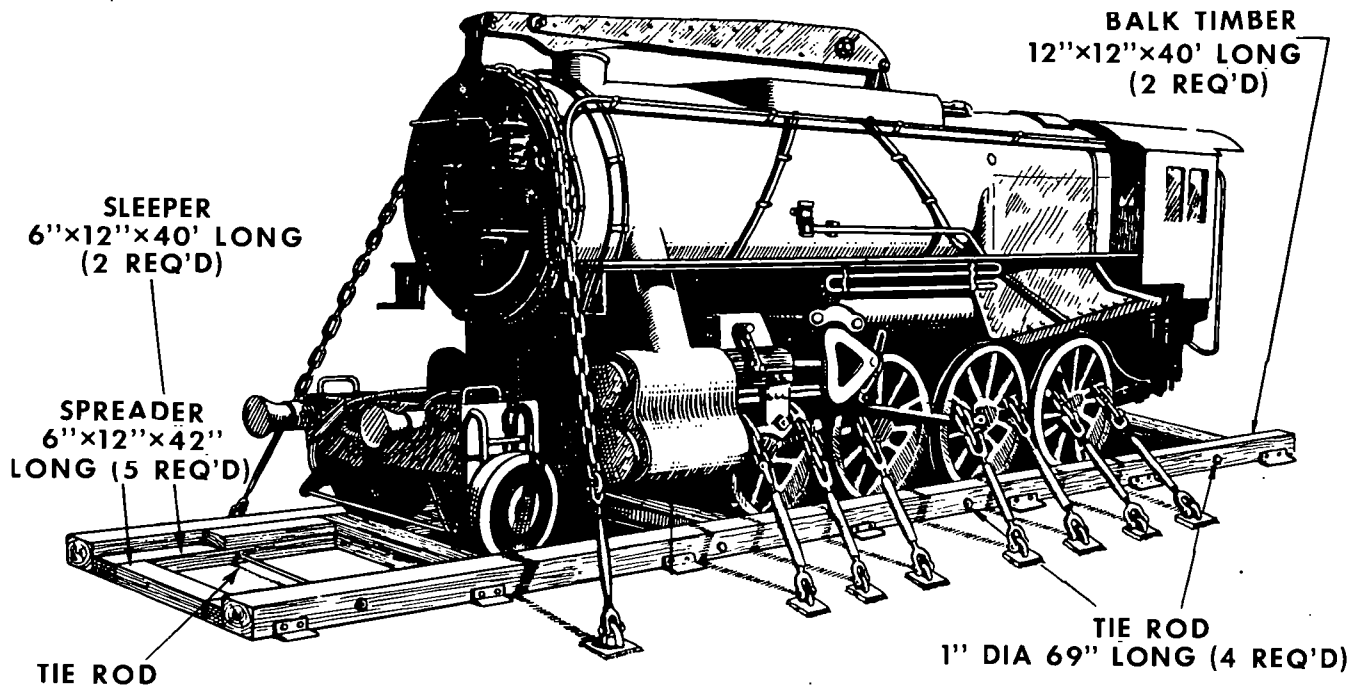


Figure 6-40. Locomotive stowed on deck.

6-41. Small Boats on Deck

Watercraft present a special transportation problem because of their size, weight, and comparative fragility. Almost all watercraft are so large that they must be stowed on deck. Cradles may be constructed by the manufacturer, especially for the particular type of watercraft; however, in most cases the loading activity has to fabricate them from available materials. Since the craft sit high in the air, they are exposed to wind and sea more than most cargo; lashing must therefore be applied with special care.

6-42. Construction Materials on Deck

Military cargo often includes construction

equipment of all sizes and shapes. Items of this nature that may be loaded on deck include hangar doors, oversize fuel tanks, road and runway building equipment, etc. In the continental United States, special equipment is usually available to handle this cargo, but in overseas areas it may be necessary to improvise a means to move the items with the equipment on hand. As soon as they arrive, a careful study of the stowage plan and the ship's papers will help determine what special equipment is needed; steps should then be taken immediately to prepare special handling equipment so that it will be ready when needed.

Section VIII. DISCHARGING CARGO

6-43. Rigging

Normally, when a ship arrives at the discharge point its gear is rigged and raised. The ship's crew rigs the gear just before the vessel arrives so that the terminal operations personnel should need only to spot the booms and proceed immediately with the discharge.

6-44. Discharging Deck Cargo

Deck cargo should be unloaded first. Even deck cargo that will not interfere with the discharge of

the hatch should be removed first to provide more room to work on deck, unless it is destined for another port of call.

6-45. Blocking, Lashing, and Dunnage Material

a. All lashing material should be removed from the ship unless otherwise instructed. This material should be processed as follows so that it may be used again if the need arises:

(1) Wire rope clips should be removed and nuts replaced. The clips should then be assem-

bled, sorted by size, and placed in bins or boxes plainly marked with the sizes of the clips.

(2) Wire rope should be coiled, tied off, and tagged to show the size of the rope. If the wire is to be stored for a long time, it may be lubricated and boxed. Wire of the same diameter and approximately the same length may be placed on reels if the amount of lashing received warrants such action.

(3) Turnbuckles should be opened, sorted by size, lubricated, and placed in bins or boxes marked with the size of the turnbuckles.

(4) Shackles should be removed and pins replaced. The shackles are then sorted by size and placed in boxes or bins marked with the size of the shackles.

b. Blocking material should be removed from the ship, cleaned, and sorted so that it will be available when needed.

c. Discharge of dunnage material is discussed in paragraph 6-6 e.

6-46. Breaking Out Cargo in Holds

a. Cargo in a hold should be kept as level as possible during discharge. Breaking out cargo stacked higher than a cargo handler's reach or tunneling under other cargo is very dangerous.

b. It is a common practice to load general cargo, drummed cargo, and barreled cargo in the wings and ends of the hatch and vehicles and heavy lifts in the square. When discharging cargo loaded in this manner, tables or platforms should be built up in the square of the hatch near the coaming so that the cargo can be handled without damage to cargo or injury to personnel. These

tables may be constructed of lumber on the pier or of pallet boards. When pallet boards are used, dunnage must be laid on top of the pallets to make a solid floor for the men working on the table. For light cargo, tables may be necessary only until enough cargo has been removed to enable men to stand on the cargo and pass it down. For heavy cargo, such as asphalt in barrels or POL in drums, tables should be used until the cargo can be handled from the deck without reaching.

6-47. Discharging to Barges

a. Offshore discharge of cargo using watercraft is necessary when terminal facilities on shore are unavailable or when a vessel must be lightened. Discharge can be expedited by using a floating crane and barges on the offshore side of the vessel, in addition to working cargo on the pier.

b. Since very few barges are equipped with cargo handling gear, shore cranes or other devices must be available for their discharge.

c. Barges should not be worked in rough seas unless absolutely necessary. The use of barges is usually restricted to harbors, inland waterways, rivers, and protected anchorages.

d. Cargo should be evenly and tightly stowed in barges and evenly discharged to prevent lighters from capsizing.

e. Personnel must take the same precautions in handling, separating, dunnaging, chocking, and lashing special cargo such as ammunition, vehicles, and heavy lifts on barges or lighters as they would aboard ship.

Section IX. TERMINAL CLEARANCE

6-48. General

a. One of the most important phases of stevedoring is terminal clearance. Cargo that is allowed to accumulate on the pier hinders discharge and eventually brings the operation to a standstill. Accumulated cargo is subject to damage and pilferage.

b. Terminal personnel must clear cargo from the terminal as quickly as possible. The type of cargo stowed aboard ship influences the method of pier and terminal clearance.

6-49. Vehicles

a. In combat loading, vehicles are normally loaded so that they can be driven from the pier or landing craft under their own power. All that

should be necessary is to connect the batteries. Vehicle gasoline tanks are three-quarters full when loaded.

b. Vehicles for stock or resupply are frequently processed for shipment before being loaded so that they must be towed off the pier by other vehicles or tractors.

6-50. Cargo for the Services

a. Block-stowed cargo of one service may be loaded directly into trucks and trailers or railway equipment for delivery. This is a fast and efficient method of terminal and pier clearance because the cargo is handled only once.

b. If quantities of cargo belonging to several services are being unloaded, clearance carriers

may be lined up on the pier according to service, and drafts of cargo can then be transported to them from the hook with forklifts.

6-51. Temporary Holding Areas

a. Temporary holding areas are required when the rate of discharge exceeds the capability of clearance transportation. Covered areas should be used whenever possible or available, and particularly if the cargo is subject to weather damage or is expected to remain in the terminal area for extended periods of time.

b. After considering the consignees of goods and the facilities available, the commander of the

discharging terminal generally establishes these holding areas so that goods may be segregated by destination or commodity. Segregation by destination is usually the most appropriate method, although incompatible items such as ammunition and fuel are still segregated on a commodity basis for safety reasons.

c. Under the administrative support, theater army, 1970 (TASTA-70) concept of shipping items in as direct a manner as possible to the using unit, the practice of segregating cargo by destination is increasing.

Section X. PREVENTING DAMAGE TO AND LOSS OF CARGO

6-52. Damage In Transit

a. Frequently, cargo is damaged in transit before it is received at the piers. The checker must inspect the cargo carefully while it is being received. If the checker has any doubt about a package being damaged internally, he should annotate his documents accordingly, have the package placed to one side if possible, and advise his supervisor.

b. Packages with insufficient packing and those that show signs of wear and tear or of attempted pilferage should be recoopered before loading. If this is impractical, they should be returned to the warehouse for disposition. The condition of such cargo almost always worsens during the voyage. It not only arrives at the destination damaged, but it may damage adjacent cargo.

c. Security cargo must never be recoopered without specific authority of the courier or security officer.

6-53. Damage in Handling

Damage in handling is caused chiefly by exposure to inclement weather conditions, carelessness, and use of improper gear.

a. To protect cargo from weather, hatch openings must be covered with hatch tents. These also provide protection for the men working in the hatch. Tarpaulins used to cover the remaining cargo in the square of the hatch will do much to reduce damage. However, it is useless to protect the hatch and the cargo if the cargo is allowed to remain in the open on the pier after being discharged from the vessel.

b. Unsuitable or badly adjusted slings may dislocate or break packages and damage their contents. The following precautions should be taken when using slings:

(1) Avoid crushing light or fragile articles in net slings, and avoid banging drafts of cargo against the hatch coaming. Few commodities can be handled in net slings without crushing.

(2) Avoid building drafts too high. Even though the fragile boxes are placed on top, they may fall when the sling is removed on the pier or in the hold.

(3) Insure that slings are securely fastened around the load. Slings placed haphazardly may slip and part, thus allowing the entire draft to fall to the deck or pier.

(4) Avoid careless winch operations especially when handling fragile cargo. Careless handling of a load may damage the cargo in the sling, the sling itself, or the cargo already stowed.

c. Care must be exercised when using hooks, crowbars, and similar tools. The shipper's marks on boxes, THIS SIDE UP, FRAGILE, etc. must be observed.

6-54. Damage From Chafing

Chafing usually results from improper chocking, blocking, and bracing of cargo in a vessel, a railroad car, or a barge. On a vessel, cargo damage will result if the motion of the vessel causes the pieces of cargo to rub against each other or against projections in the hold. Chafing damage may also be caused by dragging cargo over rough spots or over other cargo. Chafing is dangerous with flammable cargo in metal containers, particularly if heat is produced through friction. If cargo is properly chocked, blocked, and braced, chafing is not likely to occur.

6-55. Damage From Crushing

Crushed cases and containers usually is the result

of carelessness in slinging, improper dunnaging, or pressure brought about by stowing heavy cargo in top of fragile cargo.

a. Proper stowage, shoring, and chocking will help reduce damage to cargo from crushing.

b. Continuing studies of packaging have resulted in the reinforcement and general improvement of packages. Most damage is attributed to handling and stowing rather than to the construction of the containers.

6-56. Damage From Contamination

In planning the loading of a ship, careful consideration must be given to segregating cargo to avoid damage from contamination. Many foodstuffs can be contaminated by proximity to paint, rubber, etc. Since odors left in the hold of a vessel can taint future cargo, the hold must be clean and free from odors before loading.

6-57. Damage Caused by Wet Cargo or Moisture

a. Damage caused by moisture is called sweat damage. Condensed moisture may corrode metals, mildew textiles, etc. This type of damage ruins more cargo than any other type. The methods employed to reduce or eliminate sweat damage include—

- (1) Proper preparation of cargo for shipment.
- (2) Proper use of dunnage to provide drainage and air circulation.
- (3) Use of mechanical ventilation or dehumidifying systems.

b. A frequent cause of wet cargo is an improperly closed hatch that allows sea water to enter the hold. At times it may be necessary to discharge wet cargo. In this case, special provisions for drainage and drying should be made.

6-58. Damage From Shifting

There is always danger that cargo may shift if void spaces are not adequately shored off. Violent rolling or pitching may cause a few pieces of cargo to break out of stowage and move freely in the hold. These pieces, in turn, dislocate other cargo against which they are thrown. Serious damage to the cargo and the ship can result. The following precautions should be taken to avoid damage from shifting:

a. Leave no space into which cargo may shift. Thoroughly secure and shore all cargo so that it cannot move.

b. If cargo is likely to settle, make provisions to secure it after it has settled.

6-59. Loss Caused by Pilferage

a. General. The increase in transportation crime (theft, pilferage, and hijacking) during the

past several years has reached a point where it is costing industry billions of dollars per year. Since the environment in which military supplies and equipment is shipped is essentially the same as that of industry, a similar increase in cargo theft is being experienced by the Department of Defense. The theft of cargo (other than hijacking) from ships, trucks, rail cars, warehouses, or other terminal in-transit storage areas is commonly referred to as pilferage. Pilferage includes not only petty theft but theft of any quantity or monetary value and is probably the most common transportation crime with which cargo handling personnel will be concerned.

b. Cargo Security Program. To minimize pilferage, each military terminal and transfer facility must have a comprehensively developed and continuously improving cargo security program. To be effective, the program should include the following:

- (1) Comprehensive analysis of all aspects of the cargo transfer and in-transit storage operation in order to identify security weaknesses.
- (2) Complete indoctrination in cargo security for all personnel.
- (3) Implementation of physical security policies.
- (4) Assignment or employment of cargo security personnel.
- (5) Utilization of theft-prevention and detection equipment.

c. Preventive Measures. It is unlikely that cargo pilferage will ever be completely eliminated; however, private industry, US Army Military Traffic Management Command (MTMC) operated terminals, and other Government agencies concerned with cargo security have developed techniques that are effective in reducing cargo loss caused by pilferage. Some of the measures that may be implemented in oversea military terminals are listed below:

- (1) *Security personnel.*
 - (a) Request cargo security assistance from military police.
 - (b) Appoint a terminal security officer.
 - (c) Establish port pilferage prevention and detection teams to monitor the receipt, documentation, handling, storage, and disposition of cargo passing through the terminal.
 - (d) Assign guards to all terminal exits.
 - (e) Give security personnel advance notice of cargo entering the terminal that will require surveillance and protection.
 - (f) Post a security guard or cargo checker

at open warehouses and ship's hatches during lunch and break periods.

(2) *Fences and gates.*

(a) Fence perimeter of entire terminal with chain link fence topped by three strands of barbed wire.

(b) Inspect fence daily to insure that there are no openings in it or under it that would permit objects or persons to pass through.

(c) Maintain separate gates for personnel and vehicle traffic.

(d) Provide manned gatehouse at all vehicle entrances and exits.

(e) Clear the area around the gatehouse of any objects that may restrict the guard's field of vision.

(3) *High-value and security cargo.*

(a) Provide a secure cage, crib, or vault in the shipping and receiving area for control of sensitive or high-risk cargo.

(b) Assign responsibility for receiving, accounting for, and releasing sensitive or high-value cargo to a specific individual.

(c) Maintain a record of each shipment entering or leaving the security area. The record should include: date, time, description of cargo, number and type of containers, condition of cargo, seal number, identification number of the truck or other equipment making pickup, and name, rank, and organization of the equipment operator.

(4) *Vehicles.*

(a) Establish a truck control system utilizing gate passes.

(b) Record date and hour of release on transportation control and movement document (TCMD), gate pass, or other control document so that gate security personnel can detect abnormal time lags in travel from the loading area to the gate.

(c) Responsible person should be designated to inspect the interior of each truck after unloading.

(d) Do not spot trucks at warehouses until cargo handling personnel are available.

(e) Compare TCMD or other document with loaded cargo while spot checking trucks.

(f) Establish designated parking areas for privately owned vehicles.

(g) Restrict privately owned vehicles from entering cargo handling or in-transit storage areas.

(5) *Seals.*

(a) Maintain accurate records of all seals issued.

(b) Store seals securely within a designated area.

(c) Conduct periodic inventory of seals.

(d) Limit issuance of seals only to designated personnel.

(e) Upon receipt of MILVAN's and other containers, examine door seals to see if the numbers on the seals agree with those shown on documents.

(f) Do not remove door seals from containers or trucks until unloading is ready to commence.

(6) *Locks and keys.*

(a) Establish and maintain strict control and accountability procedures for all keys to security areas, containers, and other locked cargo areas.

(b) Issue master keys only on a need-to-have basis.

(c) Number all keys and obtain signatures from recipients when issued.

(d) Recover keys from persons being transferred.

(e) Periodically change padlocks on security lockers.

(f) Change locks immediately upon loss or theft of keys.

(7) *Miscellaneous.*

(a) Always have a cargo checker present during cargo transfer operations.

(b) Close and lock containers and warehouse doors during lunch and break periods.

(c) In addition to signing each TCMD, Government bill of lading (GBL), or other cargo document, require cargo checkers to legibly print their name or use self-inking identification stamps on these documents to eliminate the problem of illegible signatures.

(d) Keep doors of railcars containing cargo closed except when loading or unloading.

(e) Where possible, secure MILVAN's and commercial containers by butting their door ends against each other.

Section XI. PERSONNEL SAFETY MEASURES

6-60. General

Safety is the responsibility of every individual involved in military cargo handling. Observance

of simple safety rules will prevent many accidents.

6-61. Boarding and Leaving a Ship

The safest way to board or leave a ship is by a properly secured gangway or ladder. A rope ladder, commonly called a Jacob's ladder, should be used when going over the side of a ship to a barge or a lighter. The Jacob's ladder must be in good condition, sufficiently long, and properly made. The ladder should be grasped by the sides, not by the rungs or steps; this decreases the likelihood of falling if a step gives way. Attempt to board the ladder at the peak of the swell. Do not overload the gangway or ladder. Shortcuts over the side to the pier or lighter using skids or riding a draft or hook are strictly forbidden except in emergencies.

6-62. Decks and Hatches

a. Decks should be kept reasonably clean and clear of gear and equipment that might cause persons to trip and fall.

(1) Hatch covers should be neatly stacked at least 3 feet from the coaming and secured so that they cannot fall into the hatch. In the 'tween decks, the covers should be stacked as far from the hatch opening as possible.

(2) Wire, topping lifts, spare falls, beam bridles, hatch tarpaulins, and other gear should be stowed neatly where personnel will not trip over them.

(3) Hauling parts of guy tackles or other rope should be coiled where they will not be damaged by cargo, gear, or hot steam pipes.

(4) Excessive amounts of dunnage should not be stowed on deck. When a small quantity

must be on hand, it should be stowed in slings so that it cannot be knocked over and will not inhibit personnel passage around the deck.

(5) Beams should be placed outboard against the rail or bulwarks. Hatch beams should lie on their sides or hard against the bulwarks so that they cannot fall or be knocked over.

b. Beam bridle slings should have taglines of sufficient length so that men may walk around the hatch to guide the beam while swinging.

c. When two compartments are being worked in the same hatch at the same time, a lifeline should be rigged to prevent men from stepping or backing off into the lower deck.

d. Men should not be allowed to walk on improperly fitted hatch covers or on hatch covers which are damaged. Hatch covers that are improperly fitted or damaged should be reported to a ship's officer so that the unsafe conditions can be corrected as soon as possible.

f. Adequate lighting should be provided in the hold and on deck at all times. Entering ships' holds or other dark compartments without sufficient natural or electric light is prohibited; using matches or open lights is strictly forbidden.

6-63. Handling Lines on Ships, Lighters, and Small Craft

a. Mooring cleats should be clear of dunnage, cargo, and any material that might interfere with the proper handling of lines.

b. Men should stand well away from a line under strain and should face in the direction of the strain.

Section XII. FIRE PREVENTION AND FIREFIGHTING**6-64. General**

a. Fire aboard a vessel may be caused by bombing, spontaneous combustion in the cargo, explosion, smoking, or carelessness. The general cause of shipboard fires is carelessness on the part of the men who load or discharge the ship.

b. Firefighting is the responsibility of the master of the vessel. He may request assistance from military forces in the immediate area. Military cargo handlers should stand by to help if requested to do so.

6-65. Preventive Measures

Fire prevention requires the elimination of conditions that cause fires or provide the materials upon which fires feed. Cargo handlers working a ship should be familiar with the causes

of shipboard fires and take the following preventive measures against them:

a. Smoke only in authorized areas whether on board a vessel or on a pier.

b. Do not park gasoline-driven equipment adjacent to cargo that could be set afire by the exhaust.

c. When removing covers from deep tanks, lift them without contacting or dragging them against material which, when contact is made, could produce a spark.

d. Use precautions when rigging electric lights or using power tools.

e. Run out firehoses when working ammunition.

6-66. Removing Personnel

a. If a fire in the hold of a vessel is blocking the escape ladder, the only way men can be removed from the hold is by hoisting. A cargo net secured to the end of cargo falls is the quickest method of hoisting the men. If pallets or platforms are used, precaution should be taken to secure the bridle to the pallet.

b. After the men have been taken out of the hold, the winches should be secured in a neutral position and the power turned off. Available men not engaged in securing the ship's gear should give all possible assistance to those fighting the fire.

6-67. Types of Fires

a. Class A fires occur with ordinary combustible materials such as bedding, clothing, wood, canvas, rope, and paper; the cooling effect of water or the cooling and smothering effect of water fog is of first importance. Unextinguished embers or ashes must be entirely cooled before firefighting is complete.

b. Class B fires occur with flammable liquids such as gasoline, oils, grease, paint, and turpentine. Smothering or blanketing is the best method of extinguishment.

c. Class C fires occur in electrical equipment. A nonconducting extinguishing agent must be used. Carbon dioxide is a nonconductor of electricity and will not damage electrical equipment.

d. Fire involving ammunition is extinguished with water.

6-68. Fire Extinguishers

a. Firefighting Systems.

(1) *Smothering systems.* The smothering systems aboard vessels are usually of two principal types: carbon dioxide and steam. Smothering systems are good for fires occurring in areas that can be made airtight. A disadvantage is that there can be no access to the fire while it is being extinguished in this manner.

(2) *Flooding systems.* Water may be used to flood a compartment where a fire is burning. However, the water must be removed after the fire is out. Moreover, there is always the danger of the vessel listing or capsizing.

(3) *Fog systems.* Fog is more effective than a solid stream of water in fighting certain types of fires. It can quickly reduce the temperature within a compartment with less damage than a large amount of water would cause. When using fog, considerably less water is required to extinguish a fire than when water is applied in solid streams. Fog has a smothering effect; the fog displaces oxygen and expands when it turns to steam, thus displacing more oxygen.

b. Hand Extinguishers.

(1) *Carbon dioxide.* A carbon dioxide extinguisher is excellent for small compartments. This type may also be used effectively on fires in machinery or in electrical motors. Carbon dioxide does not conduct electricity and leaves no residue to be removed after the fire is out. Since carbon dioxide smothers a fire by displacing oxygen, a man operating an extinguisher cannot stay in the area for a long period of time. The carbon dioxide "fog" given off by the extinguisher, if not removed, will blister the skin and cause painful burns. The 15-pound unit is the standard hand extinguisher aboard ships. The correct method of using the extinguisher is to grasp the handle in one hand and direct the valve with the other.

(2) *Foam or foamite.* The foam or foamite extinguisher is used for a deep-seated fire. A heavy blanket of foam covers the blaze so that no air can reach it. The principal disadvantage is that the foam must be cleaned up after the blaze has been extinguished. This extinguisher is particularly effective against oil and gasoline fires. It is held upside down in one hand and the foam directed with the other.

(3) *Soda and acid.* When an extinguisher containing soda and acid is inverted, the sulfuric acid is automatically released. The action of the acid on the soda creates the necessary pressure to propel the extinguishing stream. This extinguisher is easily refilled and is very good for a small deep-seated fire. It is operated in the same manner as the foamite extinguisher. Caution should be exercised when using this extinguisher since the acid may damage clothing or burn the user.

(4) *Water pump.* A water pump is merely a small drum filled with water, with a handpump attached. Pressure is created by operating the handpump.

c. Fundamental Rules.

(1) Fire should always be attacked as soon as possible with the extinguishing agent best suited to the burning material.

(2) Bulkheads and decks of adjacent compartments should be kept cool to prevent the fire from spreading. Fires in confined spaces may be brought under control by excluding air.

(3) Class A fires leave embers that might reignite; this is especially true of fire brought under control with carbon dioxide or steam. Embers must be cooled throughout with water before extinguishment is complete.

(4) In a smoke-filled compartment, clean air will normally be found close to the deck.

(5) All fires can be extinguished by trained personnel using proper equipment.

PART TWO

CONTAINERIZATION

CHAPTER 7

GENERAL

7-1. Containerization Defined

Containerization is a general term used to describe the transportation of goods, either manufactured or bulk, in specially designed containers, so that small packages or loose items are confined into a unitized mass to facilitate handling by an individual or a group of individuals using mechanical devices. It is a method of materials handling designed to reduce the heavy costs of manhandling goods in movement from source to user. Containerization is a step in the mechanization of cargo handling.

7-2. Types of Containers

The variety of sizes and types of cargo containers in use today are too numerous to cover in this manual; representative types of demountable and stowable containers are discussed and illustrated.

a. Military Types. Military containers adaptable to containerization techniques are—

(1) *Container express (CONEX).* These containers, also known as cargo transporters, are constructed in two sizes—the standard size (type II) and the half size (type I). Size relationship between the two containers permits unrestricted intermixing in shipping, tiering, and storing.

(a) *Type I CONEX (fig 7-1 (1)).* This CONEX has a bale cubic capacity of 135 cubic feet; it is 4 feet 3 inches long, 6 feet 3 inches wide, and 6 feet 10½ inches high. It is designed for high density cargo and has a weight capacity of 9,000 pounds of cargo. Its tare weight is 950 pounds.

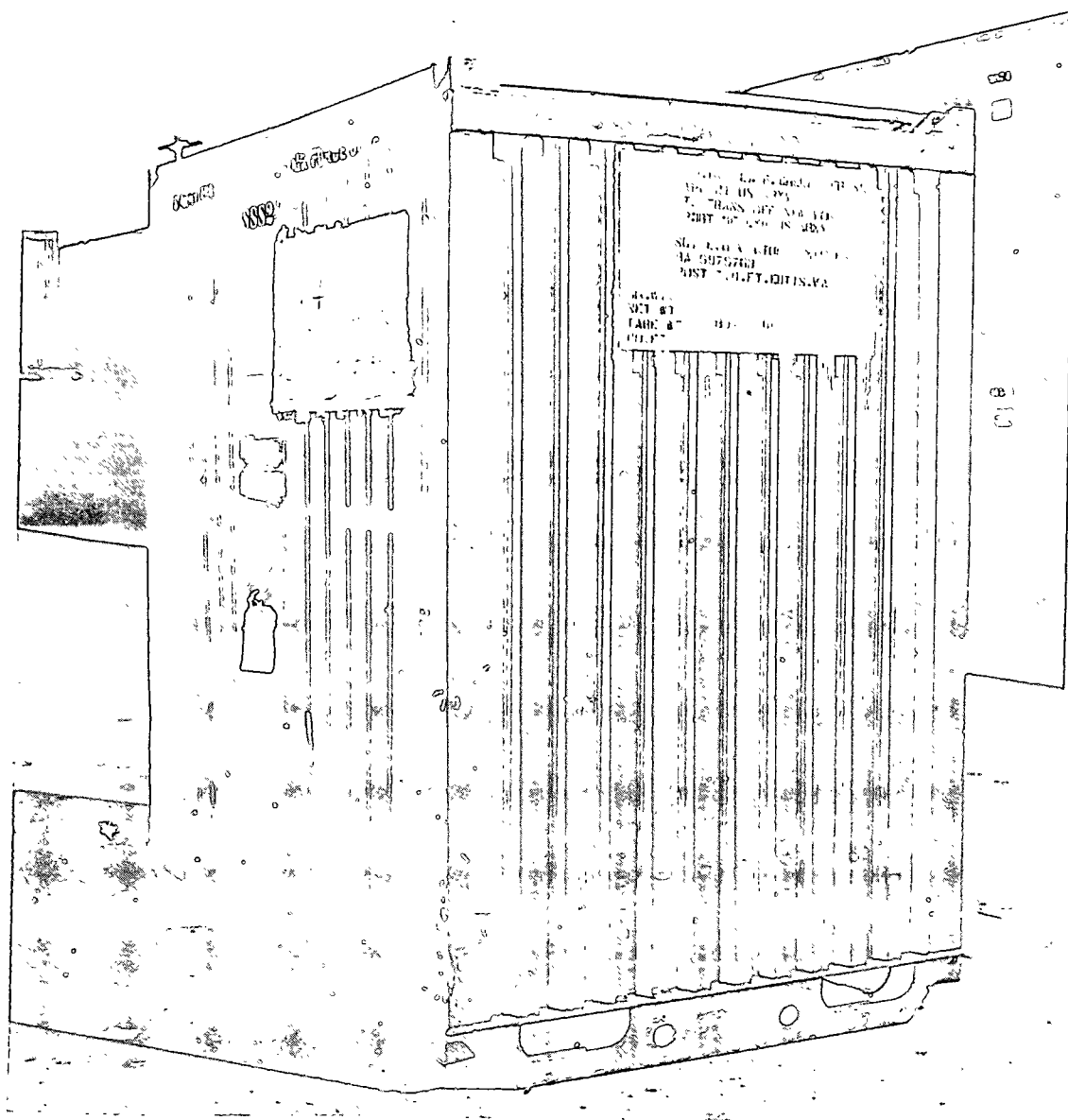


Figure 7-1(1). Type I CONEX.

(b) *Type II CONEX* (fig 7-1 (2)). Type II has been the most popular size transporter. It has a bale capacity of 295 cubic feet; it is 8 feet 6 inches long, 6 feet 3 inches wide, and 6 feet 10½

inches high. This CONEX is designed for lower density cargo and has a weight capacity of 9,000 pounds. Its tare weight is 1,430 pounds.

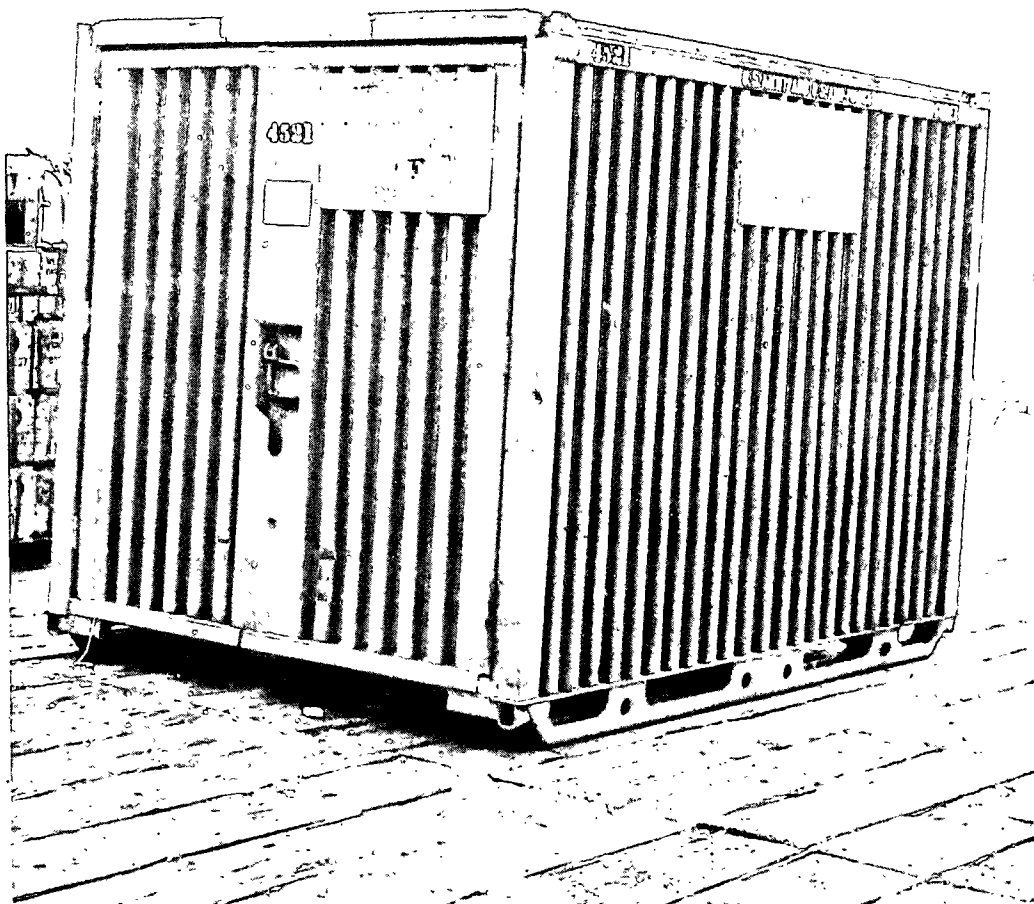


Figure 7-1(2). Type II CONEX.

(c) *Controlled-humidity (CH) CONEX* (fig 7-2). A controlled-humidity container has been developed for use with weapons and sensitive electronic equipment. It is essentially a

type II container with a steel liner and breathing system. It is classified as a separate item and is not made by modifying the regular type II container.

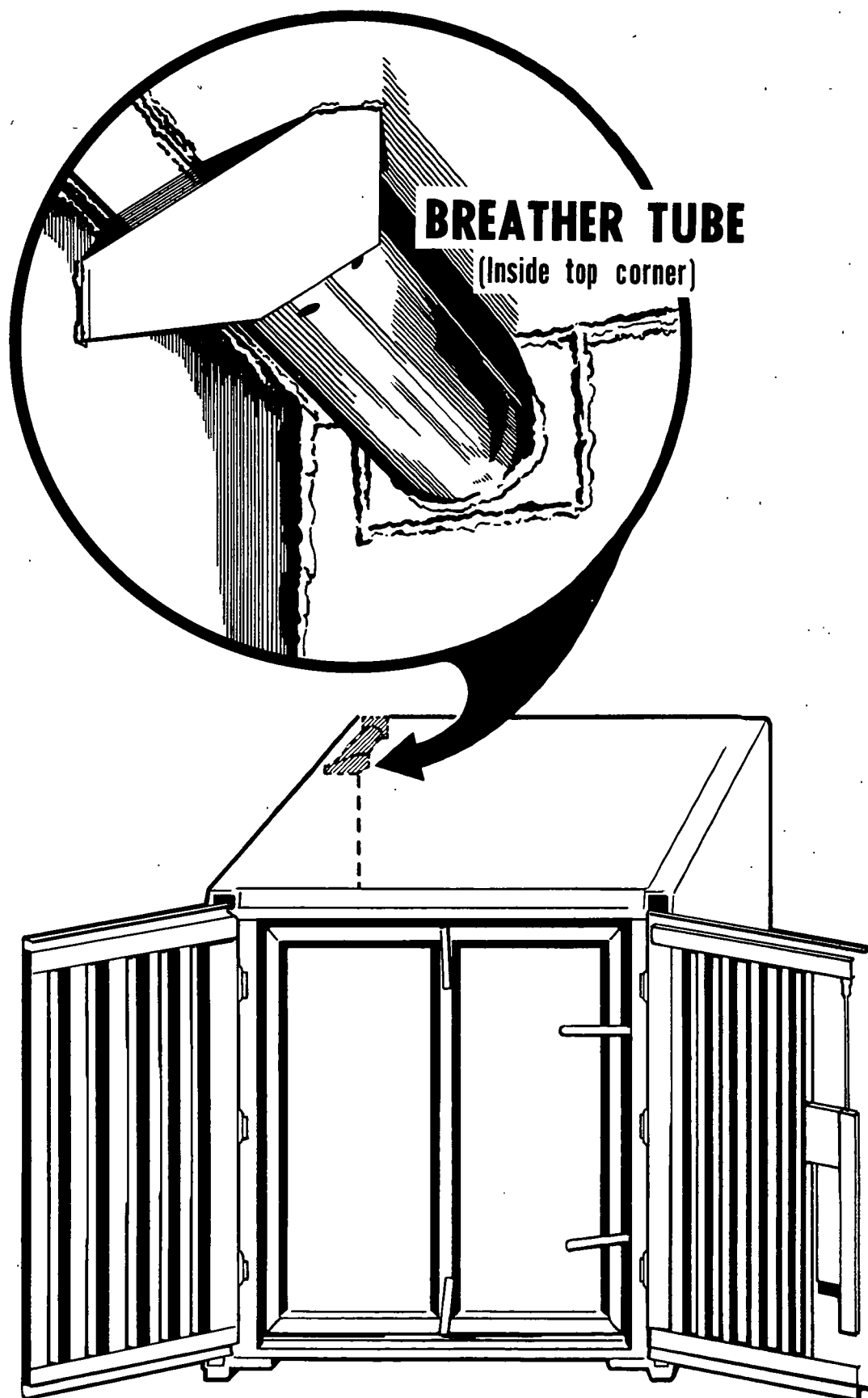


Figure 7-2. Controlled-humidity (CH) CONEX.

(d) *TRICON* (fig 7-3). In accordance with the Army's plan for through movement of supplies by containerization to the fighting man on the frontline, a new container express, known as the *TRICON*, has been developed; it has

American National Standards Institute (ANSI) standard fittings. A standard ANSI 8- by 8- by 20-foot container is formed by connecting three *TRICON*. These *TRICON* can be shipped individually or in combination.

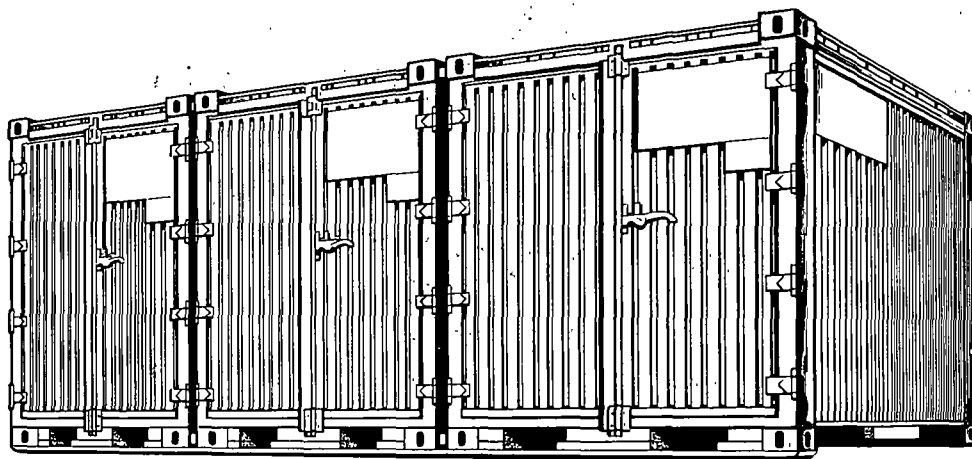
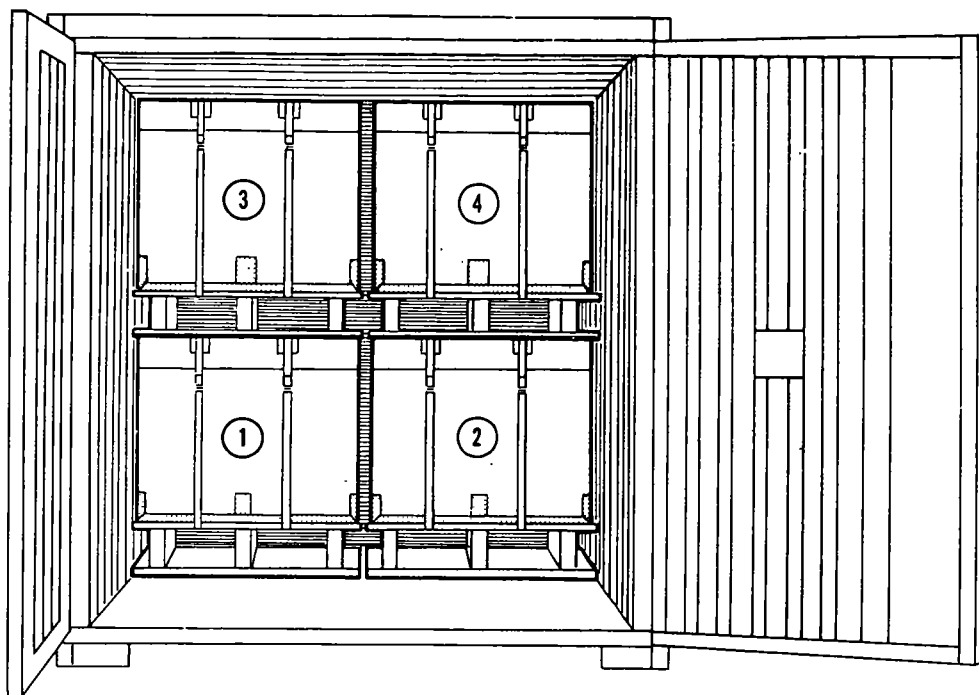


Figure 7-3. *TRICON* containers.

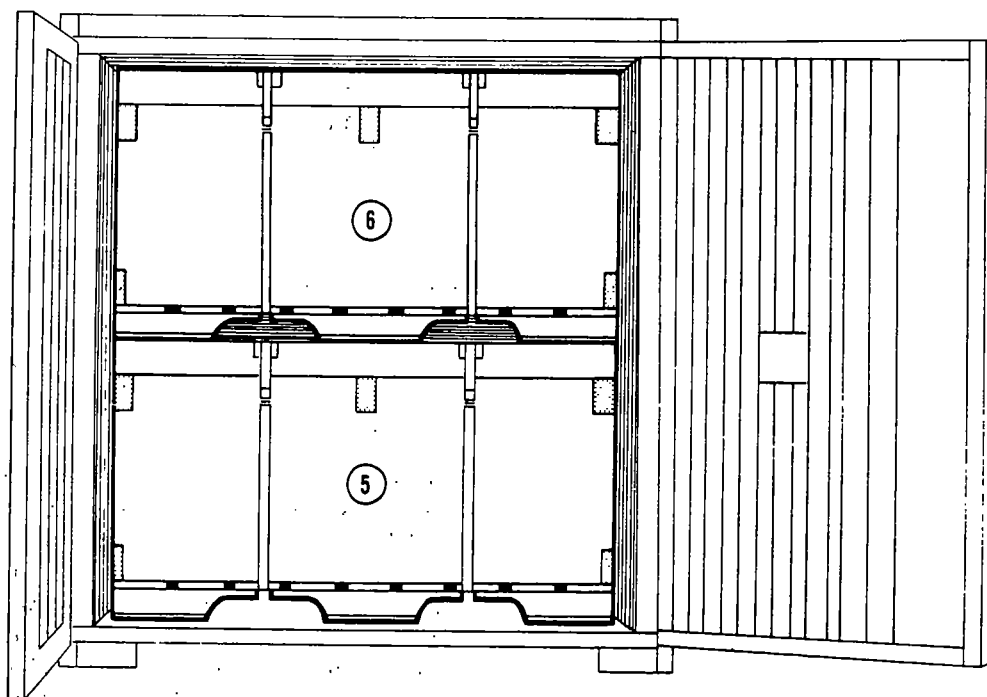
(2) *Consolidation* containers. These containers are designed for consolidating more than one line item into a single shipping container for shipment to one destination. They are primarily intended for use as stowable or insert containers for the *CONEX* and *van* containers; however, they can be handled with ordinary materials handling equipment and may be moved independently of the *CONEX*. Consolidation containers are handled separately when *CONEX* ((1) above) and *MILVAN* containers ((3) below) are not available to the shipper; this practice increases the possibility of the subsequent filling of *CONEX* and *MILVAN* containers with consolidation containers at transit points. A major

disadvantage of using these containers in *CONEX* containers is loss of cargo space. There are two types of consolidation containers.

(a) One type is an expendable fiberboard box having a triple-thick wall, with a maximum capacity of 1,000 pounds. A special reusable wooden pallet is strapped to the bottom of the container to support and strengthen it when filled and to protect it when materials handling equipment is used to move it. It was designed as a lightweight container capable of being loaded into aircraft for United States Army Strike Forces Command units. Six of them fit into a type II *CONEX* (fig 7-4(1)).



A Cargo transporter with first four insert containers in place. (Numbers indicate order of placement.)



B Cargo transporter with all six insert containers in place. (Numbers indicate order of placement.)

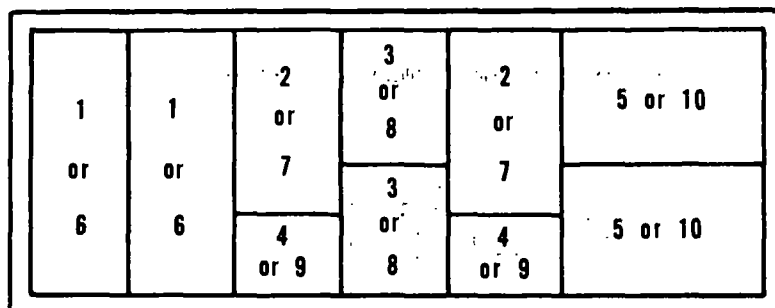
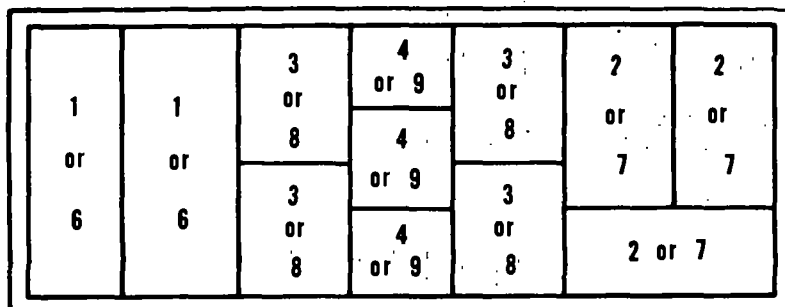
Figure 7-4(1). Insert containers loaded into CONEX.

(b) The other consolidation container, usually made of plywood, though with fiberboard and wirebound variations, was developed for use in large van containers. The plywood inserts are

especially useful in areas where it is necessary to compensate for lack of covered storage and shortage of terminal handling facilities, equipment, and personnel. They also prevent pilferage,

physical loss, and damage in shipments, as well as protect materiel against severe environmental damage in a combat area. Ten standard container inserts are listed in table 7-1. The inserts are designed to carry a maximum of 1,500 pounds,

with skids to facilitate handling with materials handling equipment. The Army Materiel Command has developed loading patterns for effective loading of these inserts into 20-foot MILVAN's (fig 7-4(2)).



Note: Numbers represent the container size number shown in Table 7-1. Example represents only one tier. Additional tiers can be identical or in any combination that will provide maximum height utilization.

Figure 7-4(2). MILVAN loading patterns.

Table 7-1. Standard Container Inserts

Container size No.	Outside Dimensions (inches)		
	Length	Width	Height
1	86	31 3/4	41
2	57	31 3/4	41
3	43	31 3/4	41
4	29	31 3/4	41
5	58	43	41
6	86	31 3/4	20 1/2
7	57	31 3/4	20 1/2
8	43	31 3/4	20 1/2
9	29	31 3/4	20 1/2
10	58	43	20 1/2

(3) MILVAN containers (fig 7-5). The Army is also using standard 8' by 8' by 20-foot MILVAN demountable, intermodal containers, which may be shipped by air, water, rod, or rail.

Movement by air is limited by aircraft weight limitations. These containers may be attached to a MILVAN chassis (fig 7-6) by coupling the lower four standard corner fittings of the container to mounting blocks on the chassis. MILVAN's have an approximate tare weight of 3,500 pounds and a gross weight carrying capacity of 44,800 pounds, but the states and the Department of Transportation often restrict loads to less when they are moved over the interstate highway system in CONUS. Moreover, experience has indicated that 20-foot containers seldom are loaded to their weight capacity as they "cube out" before they "weight out." They have a cubic capacity of 1,070 cubic feet. Two MILVAN containers and chassis may be combined to form one 40-foot semitrailer.

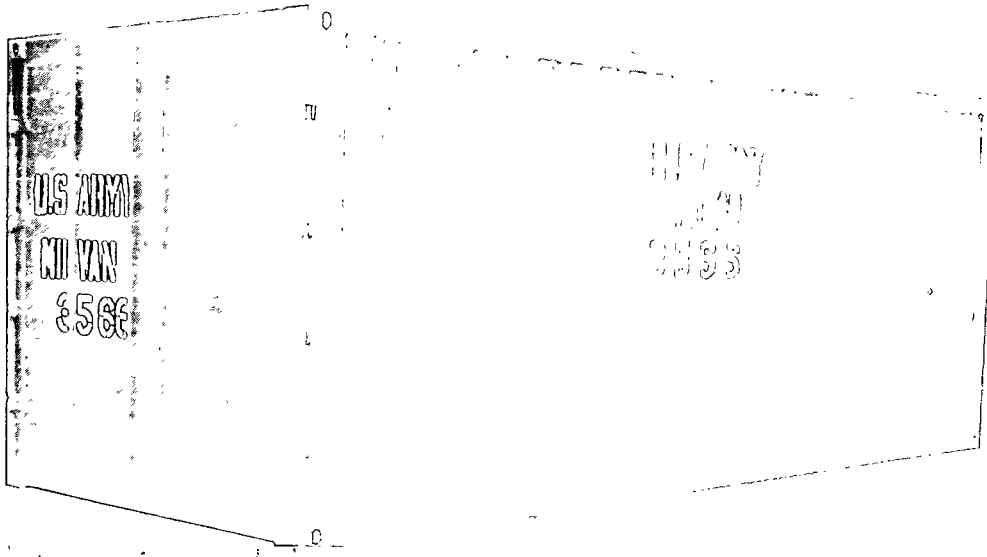


Figure 7-5. MILVAN container.

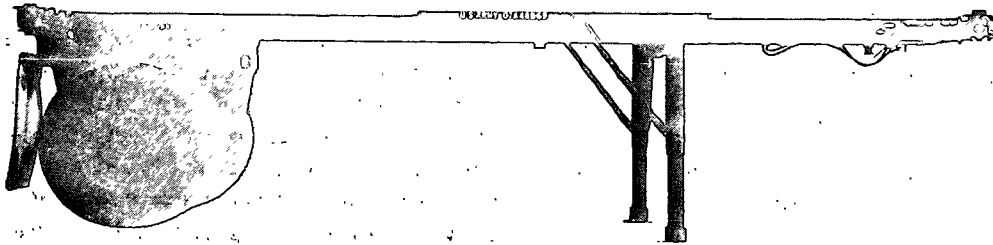


Figure 7-6. MILVAN chassis.

b. Commercial Types. The military uses commercial containers when necessary in various services, such as through-container service, shipping agreement service, and guaranteed-contract service. It is necessary that the transportation officer be familiar with the types of containers that are available commercially. In this text, commercial containers adaptable to containerization techniques are divided into two general categories, demountable and stowable. These categories include both standard and nonstandard sizes.

(1) *Demountable containers.* Demountable commercial containers are designed for practically every purpose and every type of cargo. Most major container manufacturers today are building containers to meet ANSI specifications. This makes them capable of being transported by practically all modes of transportation. Some of the types of containers available and their general characteristics and uses are described below.

(a) *Closed top, dry cargo container.* This type is considered the true van or box type demountable container. These containers are rectangular in shape and the materials used in constructing them vary; they are constructed of aluminum, steel, plywood, plastic, or fiberglass material or of combinations of these materials, depending on the structural requirements desired in the particular container. The weight and cubic cargo capacities range from 5,000 pounds and 500 cubic feet for the smallest container, to over 60,000 pounds and 2,000 cubic feet for the largest container.

(b) *Open top, dry cargo container (fig 7-7).* These containers are used when it is practical to use overhead handling equipment to lift the cargo into the van. This applies especially to items such as steel pipe, steel plates, machinery, etc. Open top containers are normally equipped with tarpaulins to protect the cargo from the weather.

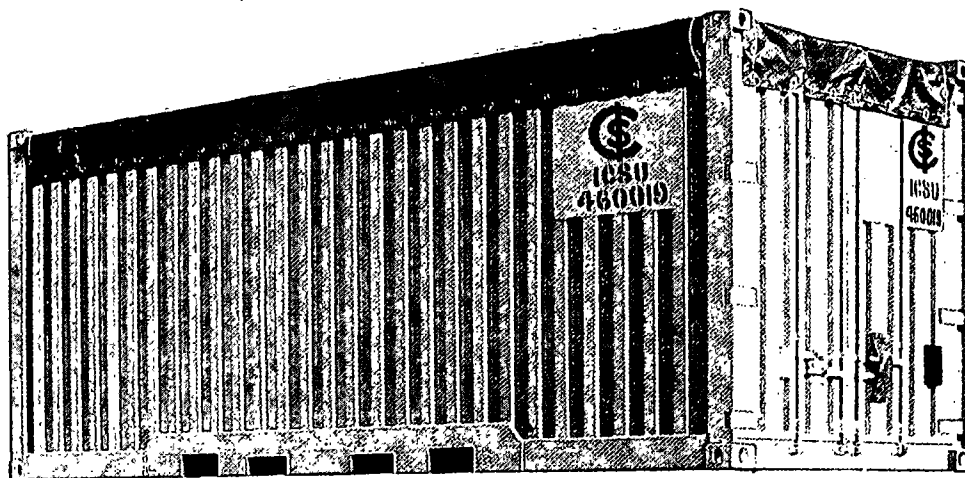


Figure 7-7. Dry cargo container, open top.

(c) *Insulated or ventilated containers.* These containers are designed for carrying such items as canned goods, drugs, film, electronic equipment, and other products that require protection from temperature extremes. The ventilated aspect of the container controls the free flow of air through the container, protecting such items as potatoes, onions, etc., that require air circulation. Internal packaging costs are reduced when this type of cargo can be moved in insulated or ventilated containers.

(d) *Controlled temperatures and/or humidity containers.* Containers of this type, equipped with temperature and/or humidity control are designed for transporting items such as meats, ice cream, etc., that require extremely low temperatures. Such items as bananas, lettuce, certain drugs, and other temperature- and moisture-sensitive items may also be transported in these containers.

(e) *Side loading or platform containers.* These containers are ruggedly built to handle construction materials such as plywood, plasterboard, bricks, drainage tile, conduit, and other items not requiring protection from weather elements. Both sides and the top are open, and they generally present a wider loading area than the van container with the same outside dimensions. This container permits easy loading from either side with forklifts or from the top with overhead cranes.

(f) *Tanker (bulk liquid) containers.* These containers are designed and built to carry most bulk liquid commodities. They may either be insulated or heat controlled, depending upon the physical characteristics of the commodity. Their construction may be of stainless steel, aluminum, or steel. These containers must be built for

compliance with Interstate Commerce Commission and Coast Guard regulations when used in handling dangerous, hazardous, or flammable products.

(g) *Car-haul containers.* Several types of containers are capable of transporting from two to four automobiles. They may be constructed of steel or a combination of steel and aluminum, and they may have open or closed sides. In the past, van containers have been used by the Army for moving military personnel's privately owned vehicles overseas. One advantage realized from using car-haul containers is reduction in loss of cubic space since the containers can be stacked or tiered. When car-haul containers are not used, the cubic space above the automobile is lost. Another advantage gained from using this type container is the reduced handling required per automobile and the resultant reduction of damage and pilferage to the automobile.

(2) *Stowable containers.* These containers are used primarily as inserts for larger containers in unit consolidation; they may be shipped as separate units in carrier equipment. They are comparable to the military triwall fiberboard and plywood consolidation containers. There are a variety of sizes and shapes, rigid or collapsible, designed to carry up to 20,000 pounds of cargo. Most are rectangular in shape and generally do not exceed 10 feet in length and are not over 8 feet in either height or width; this makes them easily transportable by flatbed truck, rail, or airfreight and capable of being consolidated in van containers. Stowable containers used for airfreight conform to the configuration of the aircraft.

7.3. Container Handling Equipment

To gain full advantage of container ship

operations, the containers must be moved efficiently, speedily, and safely through the terminal. This is accomplished by using specialized handling equipment. The type of handling and lifting equipment varies from terminal to terminal depending primarily on the container storage method used, the modes serving the terminal, and the overall layout of the terminal storage area. The design of a new terminal is often determined by the type of handling equipment to be used. (The handling and lifting equipment described in this paragraph were selected as typical of the many different manufacturers' models available; however, their selection does not indicate Army endorsement.)

a. *Forklift Trucks.* Forklift trucks may be used to handle containers, provided the containers have fork pockets on the sides and the weight of the container does not exceed the lift capacity of

the forklift. Special attachments have been designed for optimum use in handling containers with forklifts. One corporation has developed a special attachment for one of its forklift truck models to be used for the top handling of ANSI standard 8-by 8- by 20-foot containers with a maximum gross weight of 47,500 pounds. They also have a side-handling attachment for use on this model for handling partially loaded or empty containers. If desired, this unit may be installed on smaller lift trucks. Both are easily mounted and dismantled by the operator. Figures 7-8(1), 7-8(2), 7-9(1), and 7-9(2) illustrate these models. Two other manufacturers have developed experimental vehicles specifically designed for handling containers. The vehicles are termed "Front Loader" and "Side Loader" according to their loading configuration; each has a 20-ton capacity.

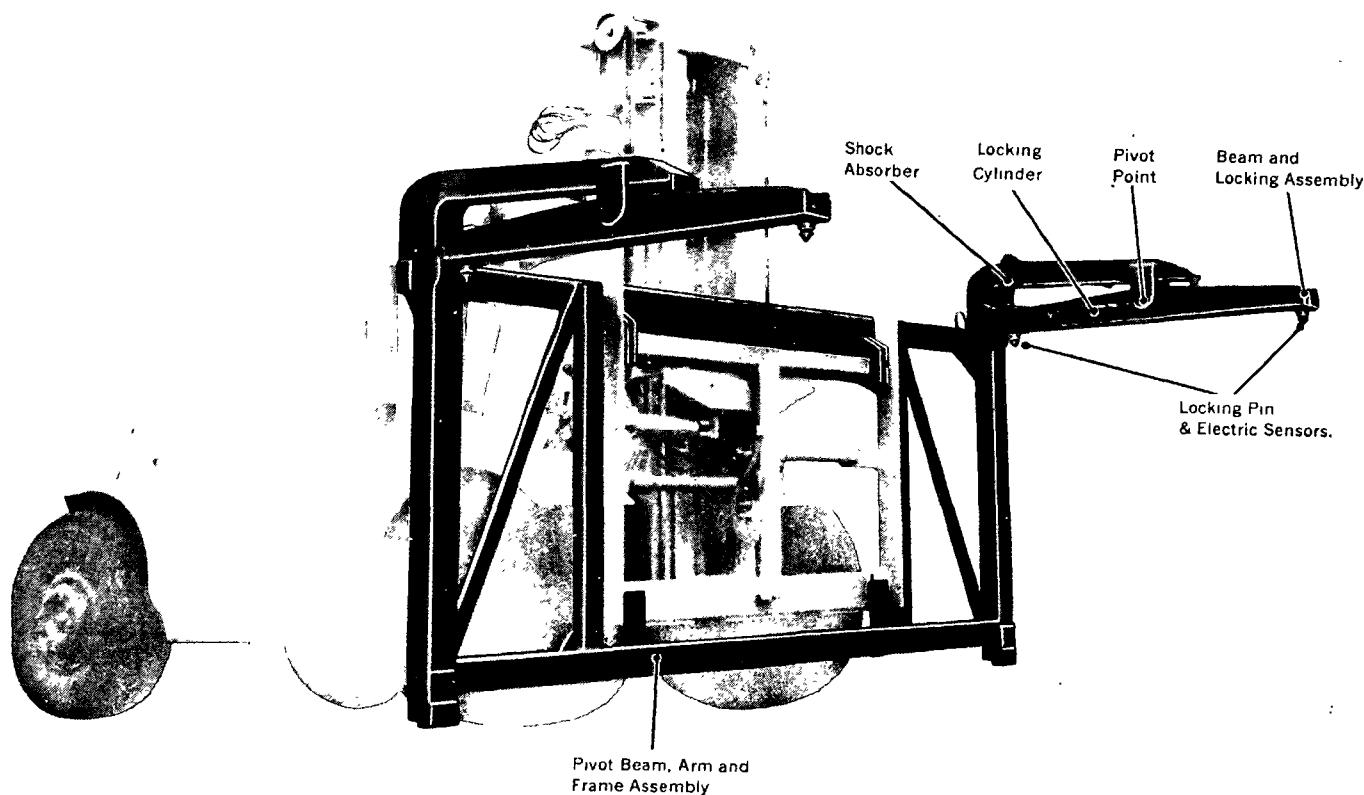


Figure 7-8(1). Towmotor lift truck with container top-handling attachment
(Courtesy of Towmotor Corporation)

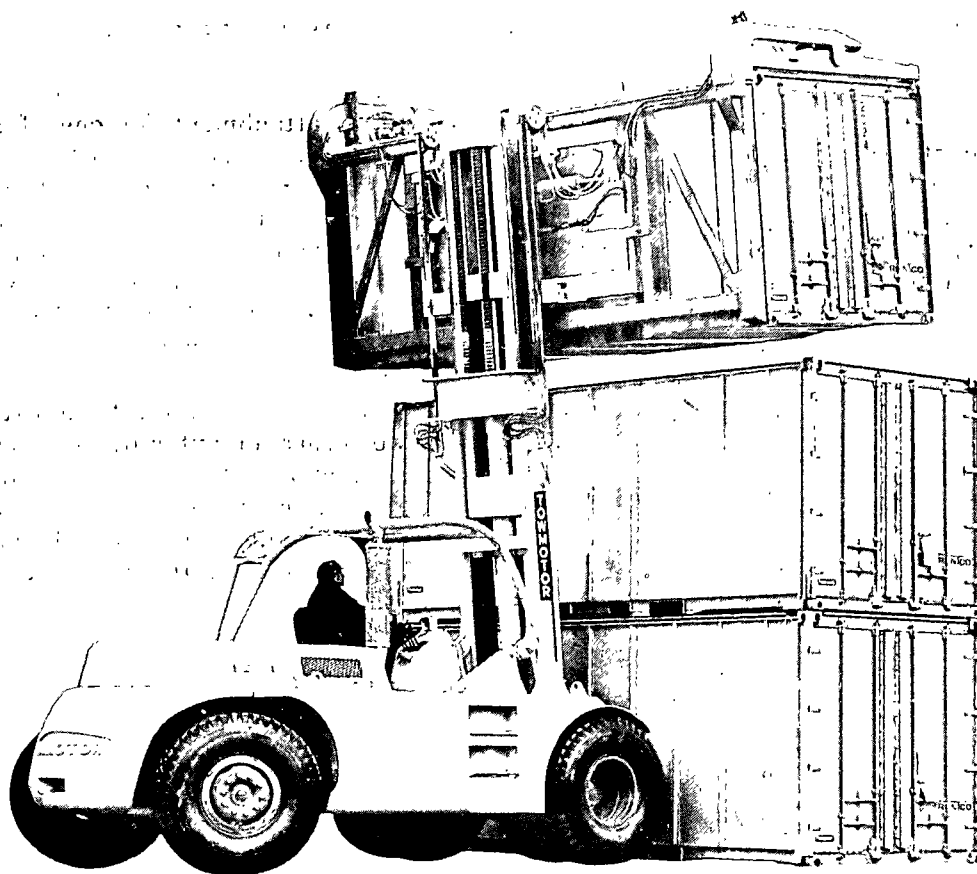
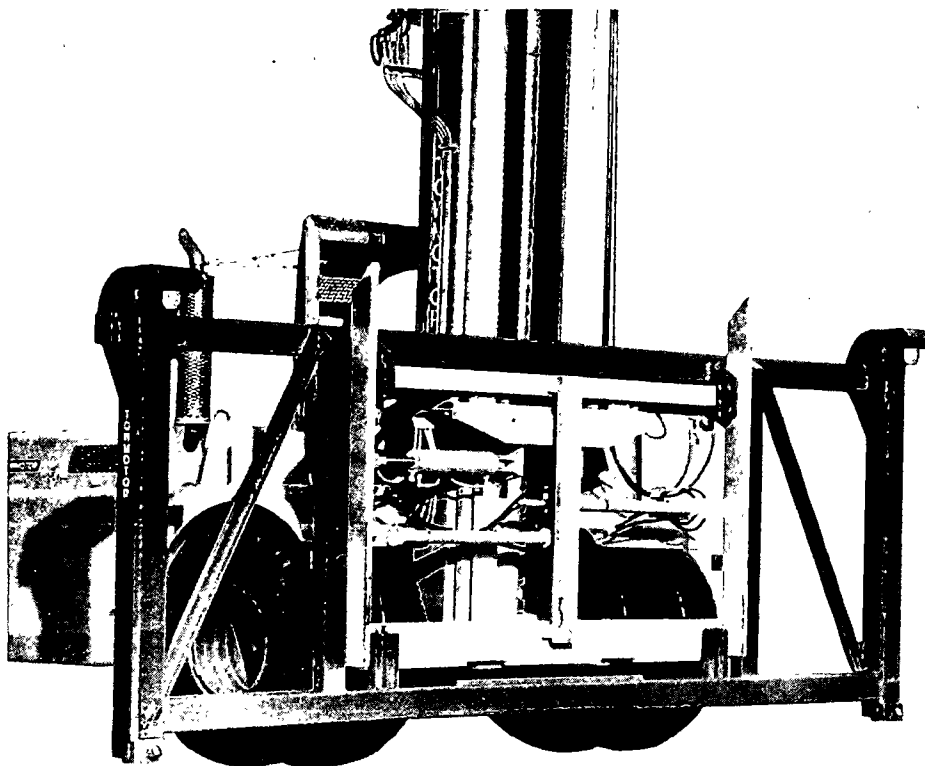
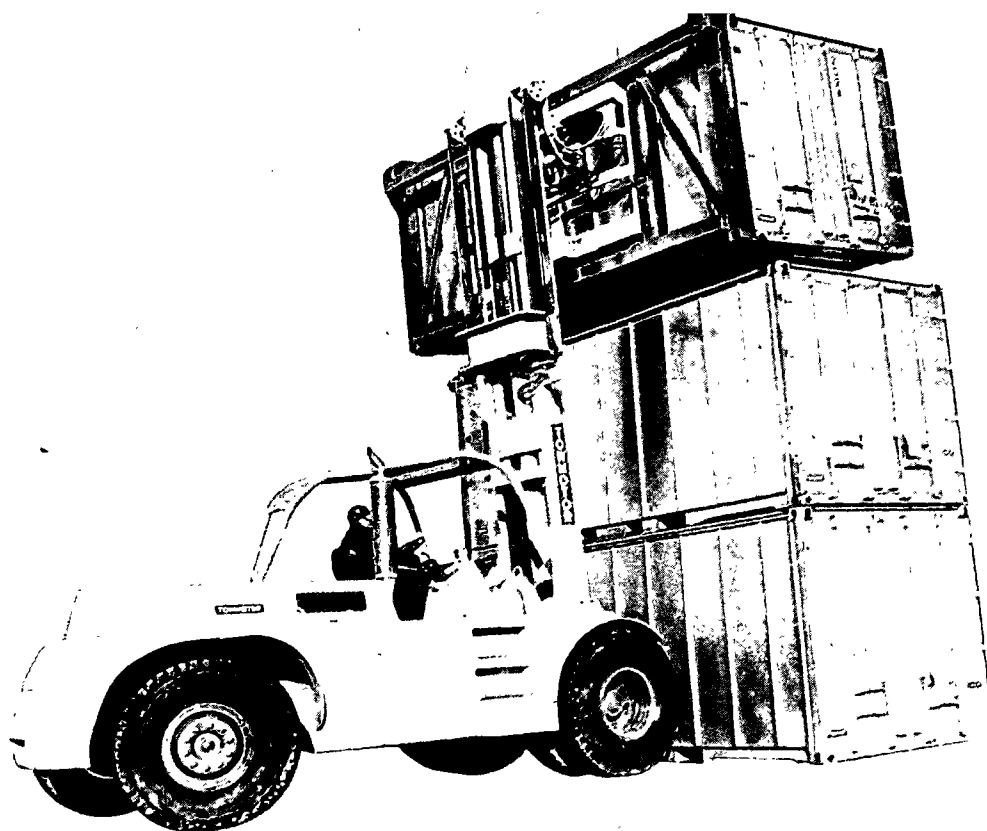


Figure 7-8(2). Towmotor lift truck with container top-handling equipment in use.
(Courtesy of Towmotor Corporation)



*Figure 7-9(1) . Towmotor lift truck with container side-handling attachment.
(Courtesy of Towmotor Corporation)*



*Figure 7-9(2) . Towmotor lift truck with container side-handling attachment in use.
(Courtesy of Towmotor Corporation)*

b. *Straddle Cranes.* Straddle cranes are self-propelled gantry cranes, either operated on rubber tires or mounted on rails. They may straddle from one to as many as six railroad trucks while loading and unloading containers and piggyback trailers. Both the tire and rail-mounted types are highly versatile, being capable of lifting up to 50 tons, moving through narrow aisles, and spotting containers in specific locations throughout the storage yard. Many have the capacity for stacking containers two and three high. The lifting device employed on the

straddle crane is usually a universal lifting spreader that fits either into special lifting slots at the top of the bottom of the container or completely underneath the container.

(1) Figure 7-10 shows a 40-ton capacity crane lifting a trailer from a railcar in a piggyback operation. With a skewing trolley, the Trans-tainer can park trailer units at an angle. This 64-foot, rubber-tired Transtainer can also stack containers three high. Since no aisle is required alongside each container, the units may be spotted side-by-side in rows of five.

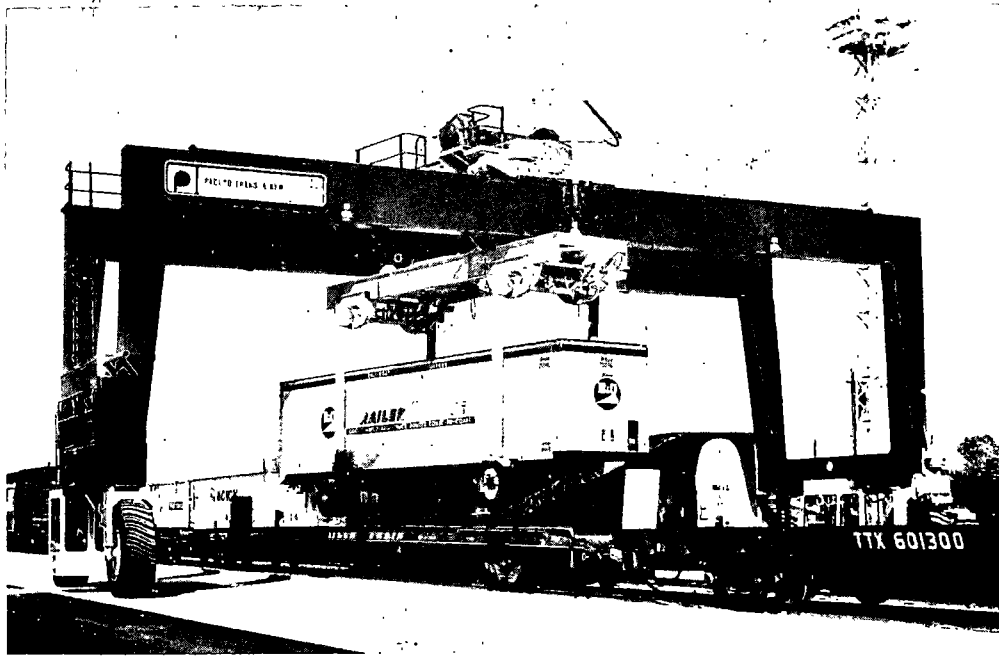


Figure 7-10. PACECO transtainer (®) rubber-tired crane.
(Courtesy of PACECO, a Division of Fruehauf Corporation)

(2) The 40-ton rail-mounted crane represented in figure 7-11 can span up to six tracks; this design allows trucks to be loaded or

unloaded from both sides of railroad cars. The trolleys rotate 360° for complete flexibility of container or piggyback placement.

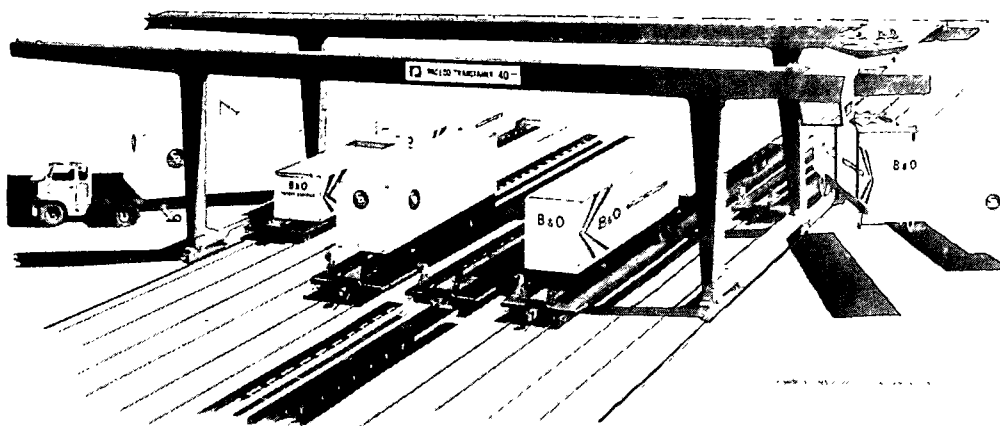


Figure 7-11. PACECO Transtrainer[®] rail mounted crane
(Courtesy of PACECO, a Division of Fruehauf Corporation)

(3) The Strad-L-Port crane shown in figure 7-12 is being operated in piggyback service. It has positive electric control for safe, fast positioning

of loads, plus the ability to angle-park containers at 18°

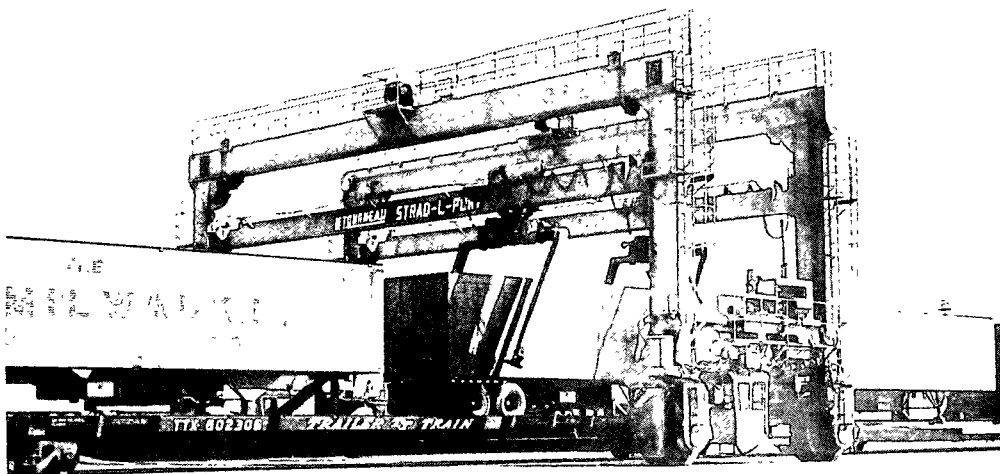


Figure 7-12. Le Tourneau Strad-L-Port.
(Courtesy of Marathon Le Tourneau Company)

c. *Straddle Trucks.* These trucks are similar to the straddle cranes, but are smaller and generally limited to straddling one container width, picking one container from its stack in the storage area and moving it alongside the vessel for loading. It is a little more versatile in its speed and maneuverability than the straddle crane. It may either lift the container from the top with the

universal spreader or from the bottom with lifting arms.

d. *Dockside Container Cranes.* The dockside cranes for handling containers are designed for quick loading and unloading, which greatly reduces the time a container ship must spend in port. By using these cranes, ship turnaround time has been reduced from 110 to 40 hours in some

instances. Container terminals have restrictive limitations peculiar to each terminal; therefore, the particular design of dockside cranes depends upon the requirements of the terminal served. Some dockside container cranes in use are described below.

(1) The Port of Norfolk, Virginia, has a typical dockside 40-ton capacity container crane (fig 7-13). These cranes are capable of handling containers at the rate of one a minute.

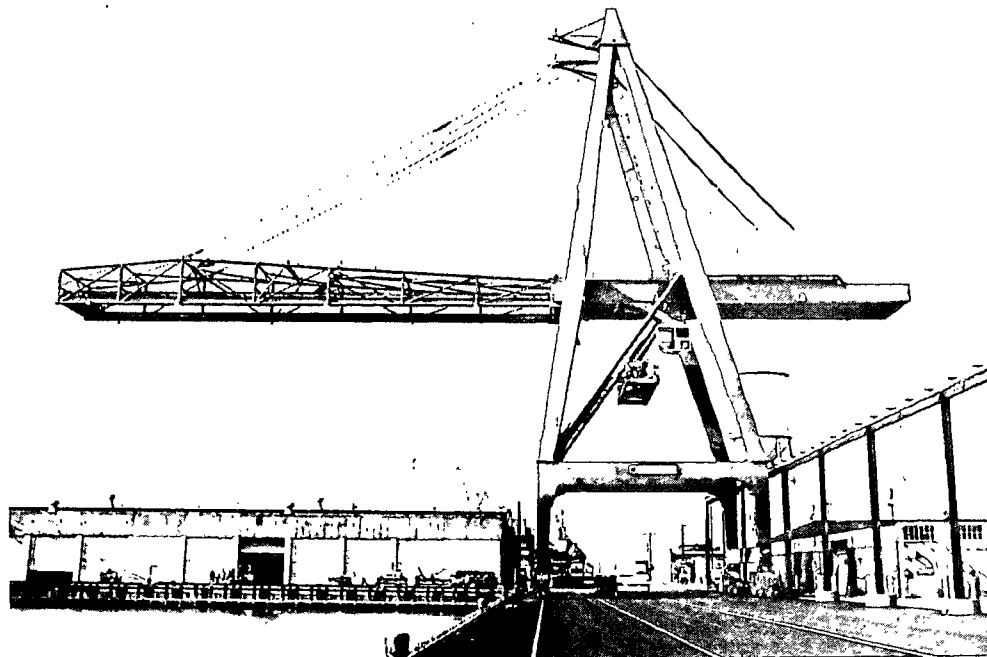


Figure 7-13. PACECO standard 40-ton Portainer ®.
(Courtesy of PACECO, a Division of Fruehauf Corporation)

(2) Figure 7-14 shows another dockside crane. Installed at the Port of Los Angeles,

California, it is capable of handling two unattached 20-foot containers, simultaneously.



Figure 7-14. PACECO twin-lift Portainer ®.
(Courtesy of PACECO, a Division of Fruehauf Corporation)

(3) Figure 7-15 shows a low profile dockside crane at the Port of Oakland, California. This

crane is near Alameda Airbase and conforms to the extreme height restrictions of the base.

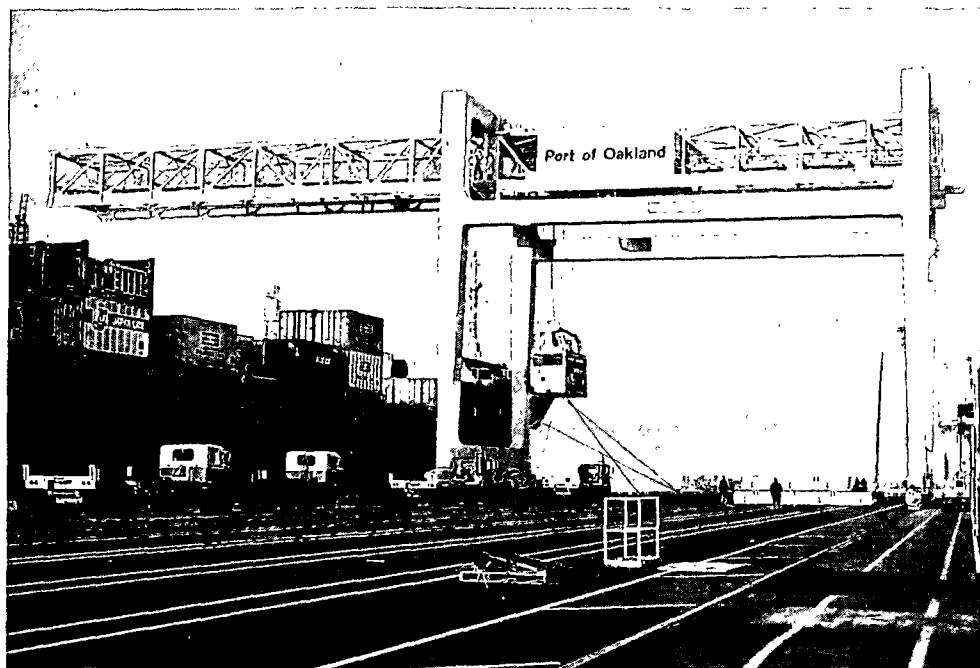


Figure 7-15. PACECO low profile Portainer ®.
(Courtesy of PACECO, a Division of Freuhauf Corporation)

(4) Figure 7-16 shows a mobile gantry crane (Model MGR-500). This crane has four-wheel drive on rubber tires. Although it weighs 675,000 pounds, widebase tires distribute the weight and

provide low ground pressure. The crane incorporates 90° steering, using ball bearing turntable design. Its capacity at its maximum work radius is 80,000 pounds.

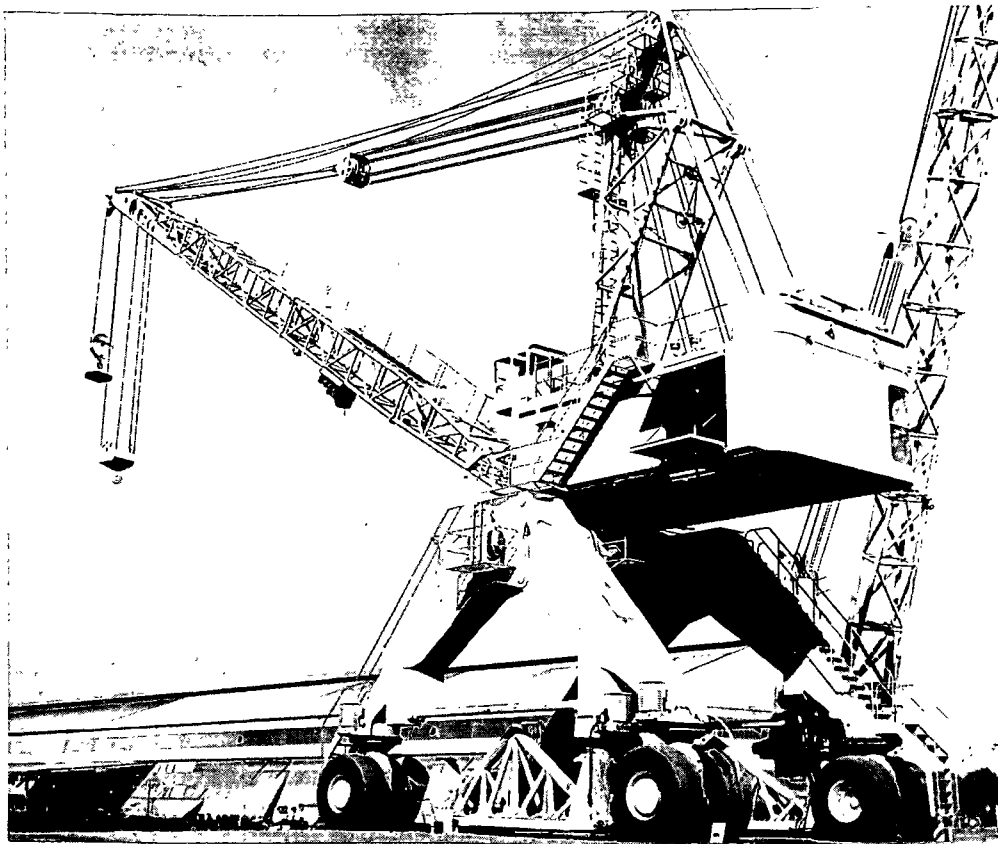


Figure 7-16. Le Tourneau mobile gantry crane (Model MGR-500).
(Courtesy of Marathon Le Tourneau Company)

e. Shipboard Container Cranes. When ports of discharge do not have pierside cranes of sufficient size and design to discharge non-self-sustaining container ships, a shipboard system must then be used. This system has been employed by a commercial contractor on its shuttle ships to move cargo from ports that had pierside container cranes to smaller ports not equipped with pierside container cranes. One disadvantage in using a shipboard crane system is that it limits the size of

the deckload the vessel can carry. Containers can be stacked three high on a non-self-sustaining container ship.

(1) Figure 7-17 shows a shipboard container crane. This hinged girder extension design has a 17-long-ton capacity and a 10-foot load outreach. The offshore boom can be raised to help compensate for list of the vessel in port. The booms fold down for compact stowage when not in use.

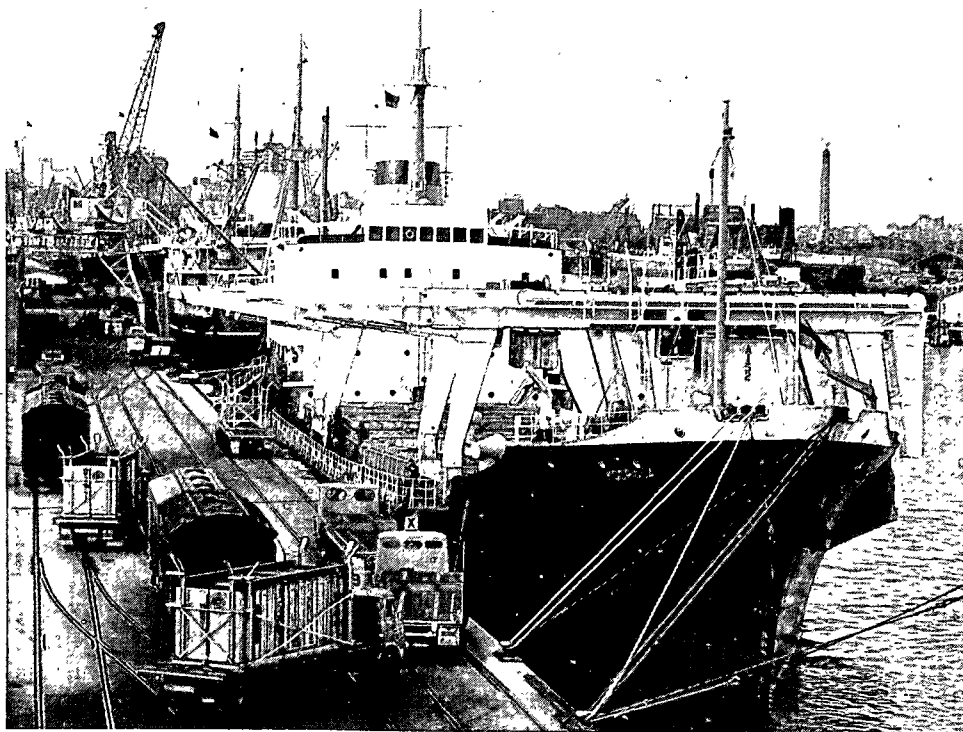


Figure 7-17. PACECO Shipstrainer ®.
(Courtesy of PACECO, a Division of Freuhauf Corporation)

(2) Shipboard container cranes, as represented in figure 7-18, are currently being built for the lighter aboard ship (LASH) program.

This crane design features a short wheelbase, fold-back girders, and a rotating trolley.

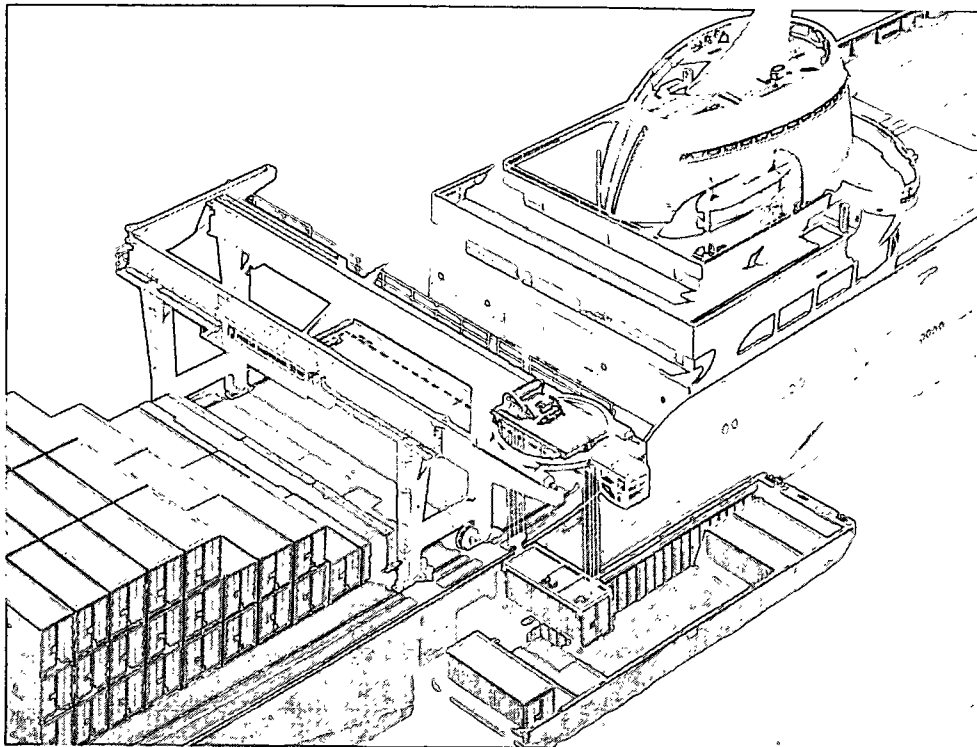


Figure 7-18. PACECO Shipstrainer® for lighter aboard ship program.
(Courtesy of PACECO, a Division of Fruehauf Corporation)

(3) Figure 7-19 is a scale model closeup of the 500-ton crane which will be used on the first 11 LASH vessels to be constructed. This crane can handle fully loaded lighters on and off the ship at an average rate of one every 15 minutes. The

crane weighs 475 tons and is operated by one man. It can handle fully loaded lighters in seas as high as 8 feet. This is the first crane of such size and capacity manufactured for shipboard use.

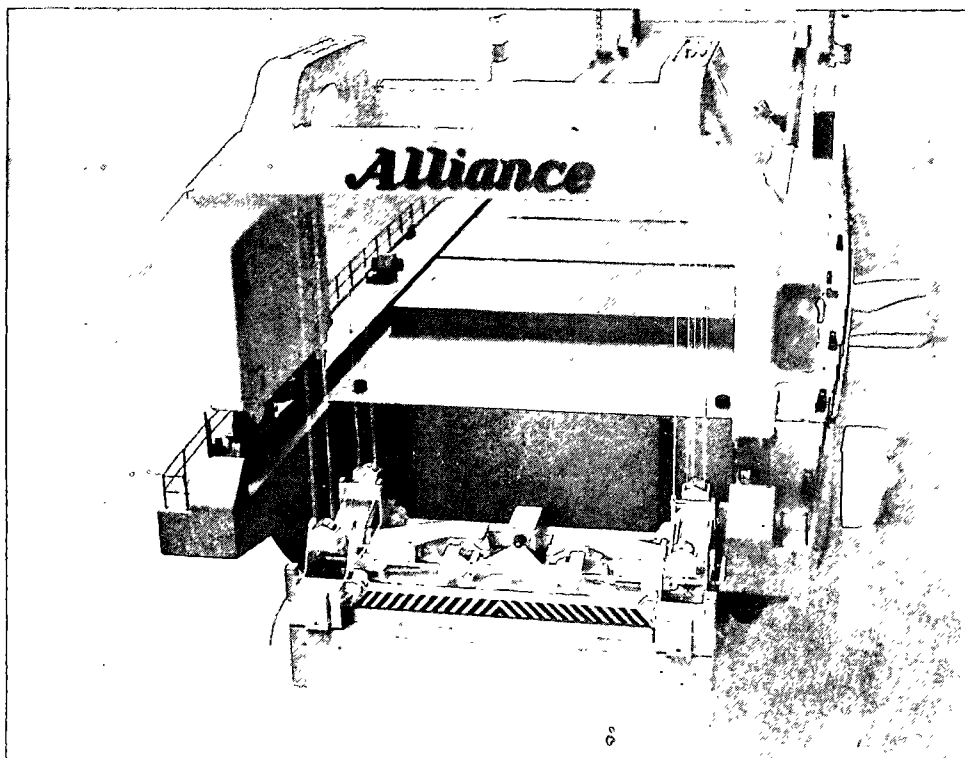


Figure 7-19. Alliance lighter aboard ship lighter handling crane.
(Courtesy of Alliance Machine Co.)

MEMORANDUM

TO : THE SECRETARY OF DEFENSE

FROM : THE JOINT CHIEFS OF STAFF

SUBJECT: [Illegible]

[The following text is extremely faint and largely illegible. It appears to be a memorandum detailing military or defense matters, possibly related to the subject mentioned in the header. The text is organized into paragraphs and may include specific recommendations or findings.]

CHAPTER 8

CONTAINER MOVEMENT SYSTEMS

Section I. THROUGH MOVEMENT

8-1. General

In a through movement system, containerization provides a materials handling method and distribution system that reduces the manhandling of goods. Within containerization systems the through movement of containers may be by a single mode or intermodal, depending on the origin, destination, and the services available or required. Single-mode through movement is moving the container from source to user by one mode of transport; for example, by highway only. Through intermodal movement is moving the container from source to user over or through more than one mode; for example, from highway to rail to water or from highway to water to highway. There are many variations of intermodal movements in CONUS and worldwide.

8-2. Systems Concepts and Types

The system concepts described herein are the intermodal type because single-mode through movement can be made by any carrier offering container service within the limitations of its physical boundaries. The types included are a cross section of systems presently in use that have application to or can become a part of an intermodal through movement system. (The military avoids exclusive type contracts for container services and encourages broad competitive participation; the types presented below are not the only systems which may be used by the Department of Defense or the Army. Competitive services provide flexibility and lower prices when selecting the container best suited to meet individual shipping requirements.)

a. Palletization. Although not a through movement system, one of the first links in the through movement chain may be the palletization of cargo. Palletization is used when an item or shipment is of insufficient quantity to warrant the use of a CONEX or other demountable type container. Here one or more line items of supply are assembled into a single load and strapped or fastened in some manner to a portable platform and handled as a unit. This unit may be moved

independently on the various modes or consolidated with other similar units into a demountable type container and then placed in the through movement system. Palletization is a realistic and economical form of unitization for shipments destined for many ports.

(1) *US Army palletization system.* The Army has a standard 40- by 48- by 6-inch hardwood, four-way entry, shipping pallet which is one of the principle pieces of unitization hardware in the Army logistics system. It is now standardized throughout the Department of Defense, and it is gaining increasing acceptance as an industrial standard as well. The ANSI is presently conducting research in pallet standardization. When using the standard Army pallet for consolidation into containers, consideration must be given to the overall height of each pallet in relationship to the inside height of a particular container so the pallets may be stacked two high without loss of cubic or weight capacity of the container. MIL-STD-147 specifies that pallets to be placed in a container must be a maximum of 40 inches wide, 48 inches long, and 43 inches high (no overhang permitted), with a maximum weight of 3,000 pounds.

(2) *US Air Force palletization system.* The US Air Force has a standard cargo unitization handling system known as the 463L system. Its principal elements are reusable master pallets which fit sets of guide rails and rollers built into all US Air Force cargo aircraft. The pallets weigh 290 pounds each, measure 108 by 88 by 2¼ inches, and can be stowed to a height of 96 inches. All cargo offered for airlift must conform to the dimensions of the master pallets, although outside items which occupy more than one pallet can be accepted. The standard Army pallet is virtually modular to the Air Force 463L pallet in that the Army pallet may be superimposed on the 463L pallet. This results in a cargo weight and cube loss, but it offers an intermodal system where palletized Army cargo can be delivered by

US Air Force planes and subsequently moved to forward areas on Army aircraft.

(3) *Other uses.* A pallet may be secured to the bottom of an insert or stowable type container to facilitate its movement.

b. *Piggyback Systems.* There are two systems that operate under the piggyback service: trailer-on-flatcar (TOFC) which is the system of transporting complete highway truck trailers on railroad cars and container-on-flatcar (COFC) which is the system of transporting the semitrailer body (container) on railroad cars without chassis, semitrailer wheels, or spring assembly.

(1) *Trailer-on-flatcar operation.* This operation consists of using a truck tractor to drive the semitrailers to an end-loading ramp and backing the trailer up the ramp onto a string of specially designed flatcars. Folding bridge plates make it possible to push the semitrailers over a string of cars for loading of the end cars first. Although this is still the most common system used, the overhead crane and giant side-loading forklifts provide a great deal of speed and versatility and may become the principal method of loading and unloading trailers.

(2) *Container-on-flatcar operation.* In addition to the overhead crane and the side-loading forklifts used in the TOFC operation, there are special systems for transferring the containers from truck chassis to railcar and reverse. One such system involves sliding the container from a bogie onto a turntable on a flatcar, using track guides and a ramming device on the tractor which pushes the front end of the container onto the railcar.

c. *Container Vessel Services.* Probably the longest and largest link in the through movement chain is made by water transport modes. Methods for moving containers over this portion of the intermodal chain may be on a conventional cargo vessel or on an ultramodern, completely containerized vessel. (Two basic system concepts, lift-on/lift-off and roll-on/roll-off, are presented below; details about particular types of vessels used in this service may be found in para 2-4).

(1) *Lift-on/lift-off container system.* This system involves lifting the container on and off conventional cargo or full-container and half-container vessels with or without the container chassis attached. In the case of a conventional cargo vessel, this may be accomplished by a slow moving onboard jumbo boom or by a shore-based crane of sufficient capacity and reach to place the container in the cargo compartments or on deck. On the container vessel, this may be ac-

complished by an onboard, giant gantry crane mounted on the vessel's deck which moves along tracks on the vessel's sides for convenient loading fore and aft or by a revolving deck crane which places the container into specially designed vertical cells or which secures and stacks the containers on deck by means of special locking devices. Shore-based cranes may accommodate both the conventional and specially designed container vessels.

(2) *Roll-on/roll-off (RORO) system.* In a full roll-on/roll-off operation, fully loaded trailers are driven aboard a specially designed oceangoing vessel, parked and secured for the sea voyage, driven ashore at the overseas terminal for movement over the highways to final destination, and then driven back to the POD for return voyage to the original POE. In the early phases of a resupply operation when both tractors and semitrailers are needed overseas, both are shipped. In routine phases of resupply and in peacetime, only the semitrailers are loaded aboard ship to be discharged by tractors at the overseas terminal. There are also in operation, partial container-trailer ships which can handle both trailers and containers and apply both the roll-on/roll-off and the lift-on/lift-off concepts.

d. *Related Services.* Container and equipment leasing services provide a valuable service within the intermodal container system. These services provide containers and equipment to meet increased demands without placing tremendous financial burdens on shipping companies. The rapid expansion in the use of containers has resulted in a continuing need for more containers and equipment. Although the military does not generally lease from commercial leasing services, leases are available and could provide a valuable source of containers for intermodal use during wartime and other emergency conditions.

(1) *Container leasing services.* The container leasing companies offer varied sizes and types of containers; however, the trend is toward the ANSI standard sizes, particularly the 20- and 40-foot sizes. After leasing the containers, the leasing companies, in most cases, follow through by providing pickup and delivery to the port of departure, thus relieving the shipper of any unnecessary administrative details and speeding up shipments.

(2) *Rail equipment leasing services.* Special railcars for use in TOFC and COFC service are available from both privately owned companies and equipment-sharing companies that are jointly owned by the participating railroads. These leasing services provide equipment to railway

companies that may be used without an enormous capital outlay by the leasee. Equipment available for leasing includes container cars and all-purpose cars. The all-purpose car is capable of transporting containers and trailers or certain bulk cargoes when containers are not available for return trips, thus making a two-way freight movement possible.

(a) *Container car.* Figure 8-1 shows two 20-foot containers and one 40-foot container loaded on a container car. The container car is an all-purpose car without trailer handling equipment; i.e., hitches, bridle plates, and guide rails.

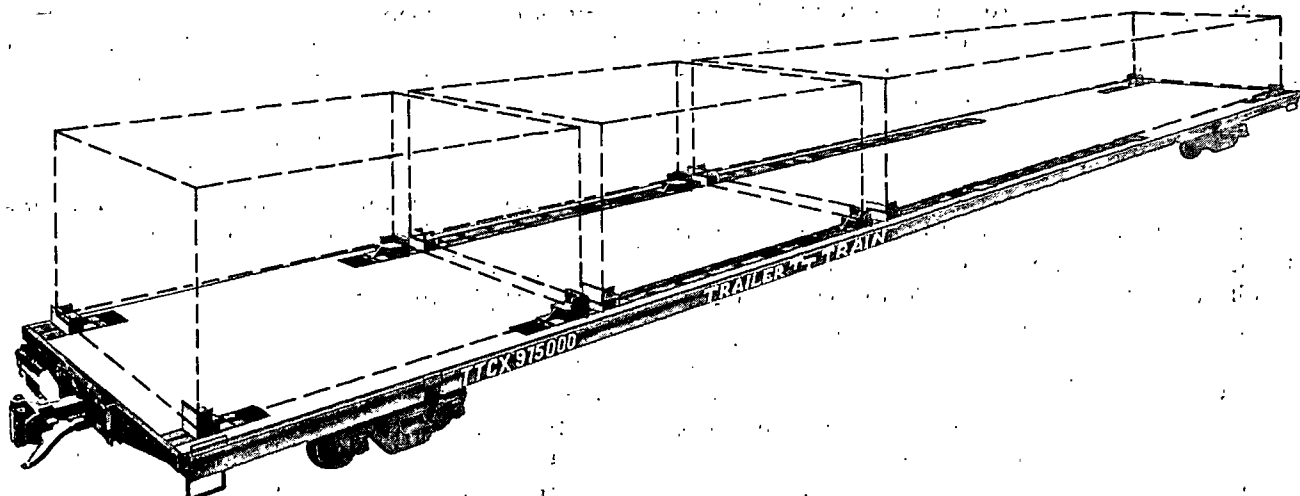


Figure 8-1. Typical load container car.
(Courtesy of Trailer Train Co.)

(b) *All-purpose car.* Figure 8-2 shows a view of the all-purpose car with one trailer hitch erected on the left to receive one 40-foot (or shorter) trailer, while to the right, eight pedestals are erected to receive two 20-foot containers. Figure 8-3 shows how the car can transport a

combination load of one 40-foot trailer and two 20-foot containers. Figure 8-4 shows the pedestal locations and the many container loading combinations that can be made. The all-purpose car can carry both standard and nonstandard containers.

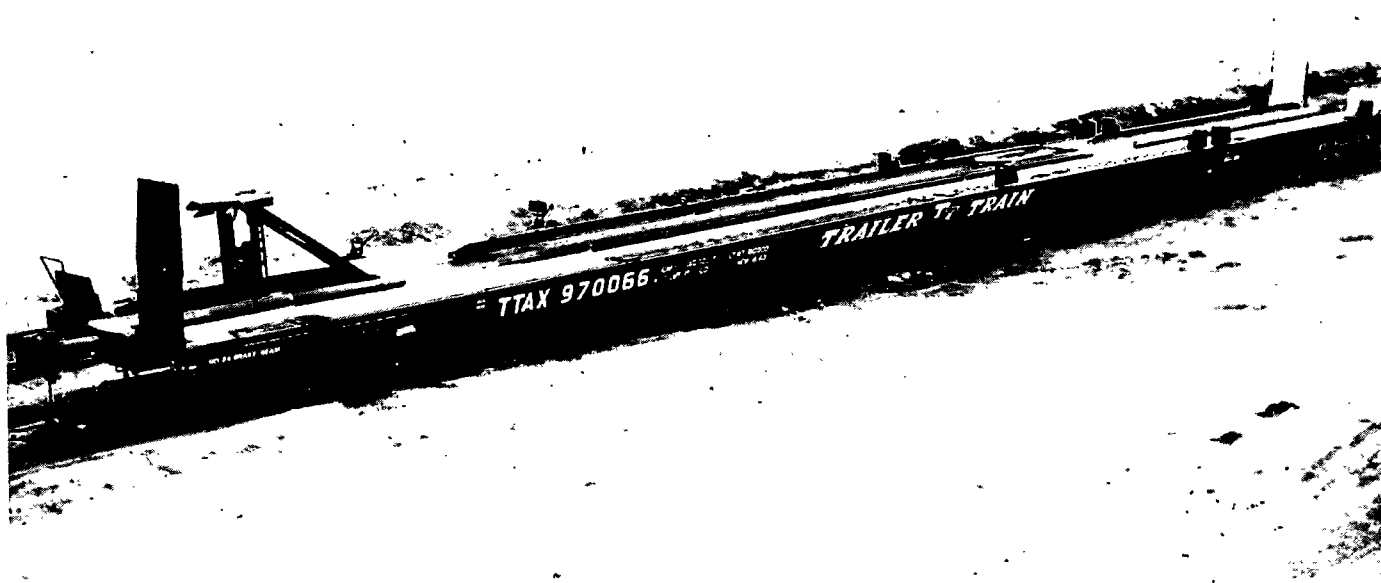


Figure 8-2. All-purpose trailer container car.
(Courtesy of Trailer Train Co.)

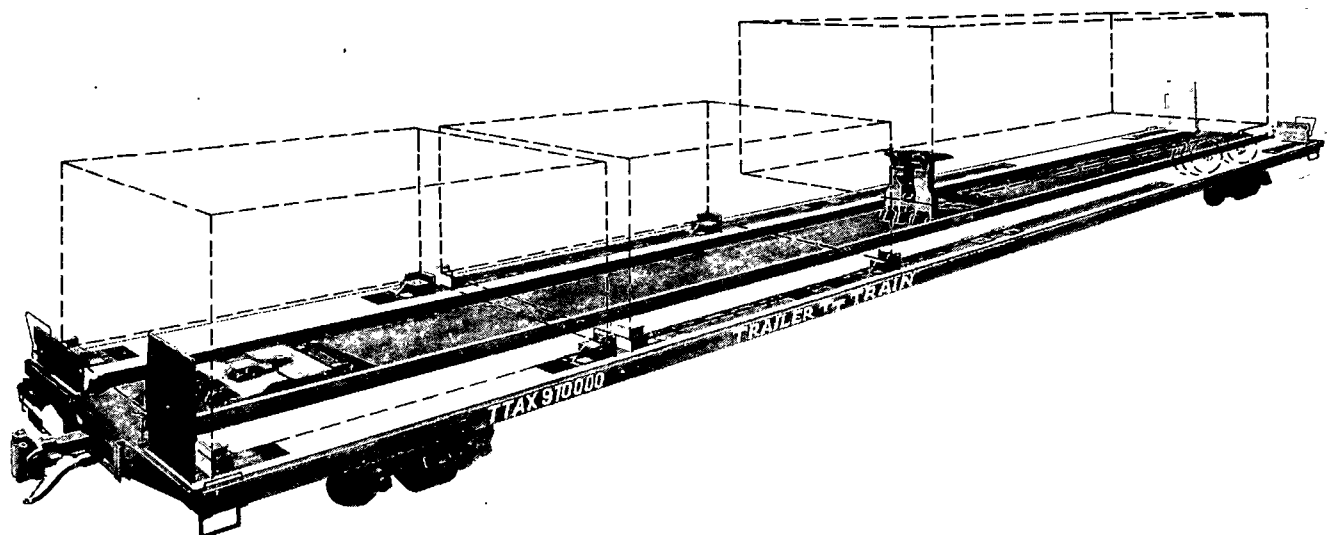
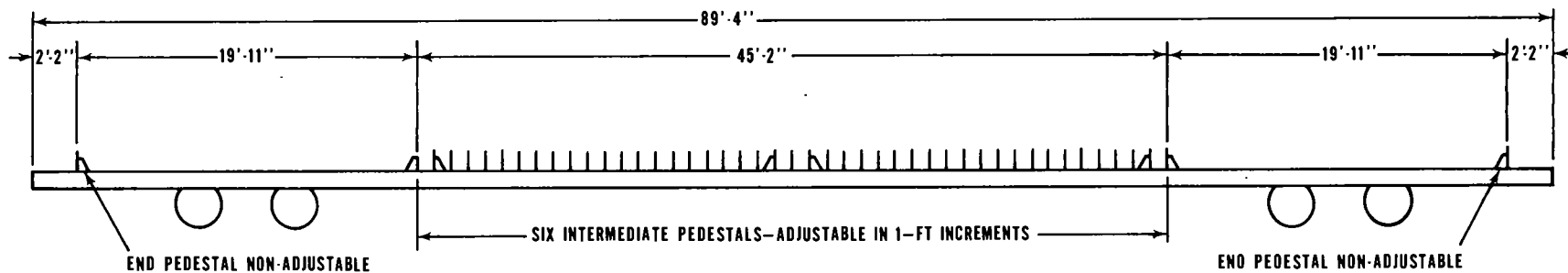


Figure 8-3 All-purpose car with combination load.
(Courtesy of Trailer Train Co)

LOCATION OF PEDESTAL SLOTS — ALL-PURPOSE CAR

WILL HANDLE ANY OF THE THIRTY POSSIBLE COMBINATIONS
OF CONTAINERS OF 20', 24', 27', 30', 35', AND 40' LENGTHS



POSSIBLE LOADING COMBINATIONS

4 - 20'	1 - 20', 1 - 24', 1 - 27'	3 - 27'
3 - 20'	1 - 20', 1 - 24', 1 - 30'	2 - 40'
2 - 20', 1 - 24'	1 - 20', 1 - 24', 1 - 35'	2 - 35'
2 - 20', 1 - 27'	3 - 24'	1 - 35', 1 - 40'
2 - 20', 1 - 30'	2 - 24', 1 - 30'	2 - 30'
2 - 20', 1 - 35'	2 - 24', 1 - 27'	1 - 40', 1 - 27'
2 - 20', 1 - 40'	1 - 24', 1 - 27', 1 - 30'	1 - 40', 1 - 30'
1 - 20', 2 - 24'	1 - 20', 1 - 27', 1 - 30'	1 - 40', 1 - 24'
1 - 20', 2 - 27'	1 - 20', 1 - 27', 1 - 35'	1 - 35', 1 - 30'
1 - 20', 2 - 30'	2 - 27', 1 - 24'	1 - 35', 1 - 24', 1 - 24'

ALL PEDESTALS FOLD INTO DECK WHEN NOT
IN USE OR WHEN LOADING TRAILERS.

Figure 8-4. Possible load combinations and location of pedestal slots.
(Courtesy of Trailer Train Co.)

Section II. MILITARY APPLICATION

8-3. General

The military has use for all the aforementioned methods, systems, and services. The application may be completely commercial or military, or it may be a combination of commercial and military modes and equipment. All applications require a great deal of coordination in meeting military requirements at the lowest delivered cost. If possible, shipments should originate as full containers at the commercial vendor or military depot, but this is not always possible because shipment sizes often do not permit full utilization of a container. Therefore, consolidation points must be established to start the through movement by containerization at the earliest possible point in the pipeline to obtain the lowest delivered cost consistent with good service.

8-4. Responsibilities

The Director of Army Transportation, Deputy Chief of Staff for Logistics, Department of the Army (DCSLOG, DA), is designated as the DA point of contact for all containerization matters. In this capacity, the Director of Army Transportation performs all staff functions necessary to insure complete and effective coordination of all containerization matters. Additionally within the Department of the Army, there are two prime agencies with responsibilities in the area of containerization and the through movement of containers—the US Army Materiel Command and the Military Traffic Management Command.

a. US Army Materiel Command (USAMC). The Department of the Army has given USAMC the responsibility for developing the overall Army containerization program. The primary objective

of this program is to establish a fast-reaction, containerized distribution system that will be responsive to worldwide military peacetime and wartime needs. The program encompasses all aspects of the transportation and physical distribution processes to insure proper integration and compatibility of one element of the system with the other. Along with this overall responsibility, USAMC is also responsible for the operation of the Joint Container Control Agency which exercises control, administration, and accountability for the fleet of Government-owned containers in worldwide service.

b. Military Traffic Management Command (MTMC).

(1) *Mission responsibility.* MTMC has Department of Defense mission responsibility for the effective and economical procurement and use of freight transportation services from commercial for-hire transportation companies operating between points in the continental United States (CONUS), except for long-term contract airlift service and control of movement into air and ocean terminals.

(2) *Functions.* MTMC, in coordination with the Military Sealift Command (MSC) and the Military Airlift Command (MAC), arranges for the movement of thousands of containers from the port areas and hinterlands of CONUS to all parts of the world in support of our deployed forces. This includes coordination with commercial carriers and the use of such services as piggyback and container vessels for the movement of military-owned or leased containers and/or trailers on a repetitive basis.

CHAPTER 9

OPERATIONAL REQUIREMENTS

Section I. RESPONSIBILITIES

9-1. General

The military services and the Defense Supply Agency (DSA) have the responsibility for proper "stuffing" and utilization of containers at origin. Containers stuffed at the continental United States (CONUS) military ocean terminals are the responsibility of the Military Traffic Management Command (MTMC). Packaging and packing of supplies are not a direct responsibility of transportation officers; however, the task of shipping materials after they have been packaged, packed, and preserved is a transportation function. The traffic manager must be able to give technical advice as to the most appropriate type and size of container to use and the recommended methods of stuffing them. Finally, the individuals responsible for the handling of containers must insure that safety precautions are taken.

9-2. Department of Defense Policy on Levels of Protection

The terms "domestic" and "oversea" as pertains to packing requirements have rather vague meanings. To enable military services to state their packing requirements objectively, a uniform policy on levels of protection has been established by the Department of Defense (DOD). These levels have been designated levels A, B, and C. Personnel may use these levels of designation as a guide when storing packages.

a. Level A. The degree of packing required for

protection against the most severe conditions known or anticipated during shipment, handling, and storage is designated level A. Preservation, packaging, and packing designated level A are designed to be suitable for direct exposure to all extremes of climate, terrain, and operational and transportation environments without protection other than that provided by the package and pack.

b. Level B. Packing required for protection under conditions known to be less severe than those requiring level A, but more severe than those for which level C is adequate, is designated level B.

c. Level C. The degree of packing required for protection under known favorable conditions during shipment, handling, and limited tenure of storage is designated level C. When containerized shipments (SEAVAN, CONEX, etc.) are used from source to user, level C is the degree of protection needed. It allows for better utilization of the available container cube for cargo stowage, thereby reducing the overall shipping cost.

d. Recommended Preservation Levels. Figure 9-1 indicates the recommended levels of preservation for oversea container shipments. (AR 700-15 contains more detailed information on conditions where more than one level may be required.)

LEVELS OF PROTECTION		
Shipments From:	Preservation Packaging	Packing
Contractors of Other Supply Sources in CONUS to Oversea Requisitioners		
(1) In support of combat operations:		
(a) For immediate use	A/B	A/B/C
(b) Storage and redistribution anticipated	A/B	A/B
(2) Other than combat operations:		
(a) For immediate use	A/B	B/C
(b) Storage and redistribution anticipated	A/B	B

Figure 9-1. Recommended levels of protection for storage or containerized overseas shipment.

9-3. Selection of Levels of Protection for Containerized Shipments

When selecting levels of protection for containerized shipments, the following conditions should be considered:

a. All the modes of transportation and types of handling to which the supplies will be subjected while in transit from the shipper to the ultimate user, especially the modes of transportation and types of handling the supplies will be subjected to prior to being loaded and after being unloaded from the container.

b. Storage conditions for containers (in transit and at destination).

c. Storage conditions for cargo (to be encountered before stowing in containers and after unstowing at destination).

9-4. Container Inspection Procedures

a. *Empty Containers.* The carrier will either place clean empty containers at the location required or the Government will obtain clean, empty containers from the carrier's terminal,

depending on the conditions of the service desired. Before stowing, the container must be inspected for cuts, holes, and severe dents which could result in water entering the container. Other items that should be looked for are broken or missing reflectors, faulty door hinges and latches, and damaged lifting eyes. A broken or bent lifting eye may mean that the container cannot be lifted and handled by the lifting mechanism of the container cranes at the pier, thereby causing unnecessary delay in delivery of the cargo and additional handling costs. Defective containers should be rejected and replacement requested.

b. *Loaded Containers.* Containers passing through transfer points should be inspected to insure that they are capable of providing required protection to cargo. Containers received with deficient preservation, packaging, packing, marking, loading, storage, or handling are to be reported by the receiver on DD Form 6, Packaging Improvement Report. This form is also used to report apparent excessive preser-

vation packaging, packing, and dunnage. When properly completed, DD Form 6 must positively identify the shipment, specify the containers by number, clearly describe all deficiencies, and include any other data which would help to point up the corrective action needed. Designed strictly as a packaging and handling control measure, DD Form 6 is not intended for reporting such discrepancies as overages, shortages, improper documentation, claims, and shipment of incorrect items. Army, Navy, and Air Force installations are responsible for properly completing and forwarding the DD Form 6. It may go to several installations or agencies, depending on the circumstances surrounding a given shipment. The basic purpose of the completed form is the reporting of deficiencies to the agency responsible for corrective action.

9-5. Marking of Land/ Sea Containers

Shipment units and shipment units in con-

solidation in a MILVAN/SEAVAN must be address-marked in accordance with the provisions of MIL-STD-129. The MILVAN/SEAVAN will be address-marked with a waterproofed Military Shipping Tag, DD Form 1387-1, attached adjacent to the seal, if required, or at the rear of the MILVAN/SEAVAN. Data for the tag is obtained from the MILVAN/SEAVAN Prime TCMD (DID T 2). (A sample tag is shown in figure 9-2.) US Army MILVANs are also permanently marked in numerous places on the container with "US ARMY MILVAN," the container's serial number, its shipping cube in cubic feet and cubic meters, its normal outside dimensions in feet and meters, and its National stock number (NSN). Other permanent markings on MILVAN's include the tare weight of the container and the maximum gross weight of the container.

EDITION OF 1 APR
66 MAY BE USED.

MILITARY SHIPPING TAG

DD FORM 1387-1,
1 APR 66

TRANSPORTATION CONTROL NUMBER A25 TAY 1266V391ML2		ROO 093		PROJECT	
FROM: LETTERKENNY ARMY DEPOT				TRANS PRIORITY 4	
TO: (POB when applicable) BAYONNE, N. J.					
POO (When applicable) BREMERHAVEN, GERMANY					
ULTIMATE CONSIGNEE OR MARK FOR USA GIESSEN SUPPORT CENTER GIESSEN, GERMANY					
PIECE NUMBER 1	TOTAL PIECES 1	WEIGHT THIS PIECE 41,300		CUBE THIS PIECE 1120	

Figure 9-2. Sample MILVAN/SEAVAN military shipping tag.

Section II. CONTAINER STUFFING GUIDELINES

9-6. General

Container stuffing refers to the process of loading cargo into a container. The objective of any container stuffing operation is to facilitate the delivery of cargo to the consignee in an undamaged condition and in such a configuration that it can be efficiently and economically unloaded. Container stuffing requires special attention because the most hazardous part of an overseas shipment is the ocean movement.

9-7. Stuffing Problems

Loading containers for ocean movement creates

many problems that are not common to highway and rail transport. One particular stuffing problem results from the fact that a shipper receiving a container scheduled for further movement cannot be sure that another shipper has not overstuffed the container or has safely stowed his cargo inside the container so that it will not shift or break loose, causing damage both to the container and the cargo. In addition, special care must be taken when label (dangerous) cargo is to be stuffed into a container that incompatible items are not already in that con-

tainer; e.g., loading paint into a container already stuffed with clothing. Containers carrying label cargo should always be properly labeled, although this is not always the case. Problems that may be encountered in oceangoing movements follow.

a. The container is handled more frequently than one moving in a domestic route.

b. The elements of weather are more severe, especially if the container is stowed on deck.

c. The vessel may pitch forward with simultaneous rolling from side to side, placing considerably more stress and strain on the contents and the containers than is experienced in a domestic shipment.

9-8. Stuffing Guidelines

Because of possible shipping problems, it is necessary that all shippers take into account the following points:

a. *Selection of Right Container.* For example, if a ventilated or a controlled humidity atmosphere is needed, the container used must meet this requirement.

b. *Cargo Compatibility.* Cargo must be compatible from a cube utilization aspect, so the optimum cube can be utilized. It must also be compatible from a contamination aspect; for example, household bleach should not be stored with foodstuffs or clothing that might be contaminated or damaged if breakage occurs.

c. *Proper Packing of Container.*

(1) Place heavy items and wet commodities on the bottom with light and dry commodities on top.

(2) Balance the load. Make sure the weight distribution is even throughout the container and

that the weight per square foot does not exceed the container specifications.

(3) Stow the cargo tightly in the container so that shifting will not occur and thus cause heavy items to be thrown through the container walls. If the cargo does not fill the container, block and brace the cargo. Since the shipper does not know whether the container will be stowed below deck or on deck, all containers must be stuffed as though they are going to be stowed on deck; that is, all containers must be watertight and capable of standing greater stress and strain than if stowed below deck.

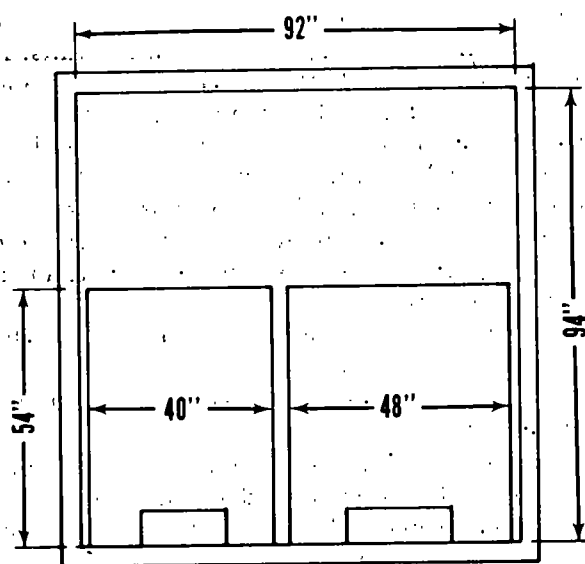
d. *Securing Container.* On completion of the loading, ascertain that—

(1) The doors have been securely closed and are watertight.

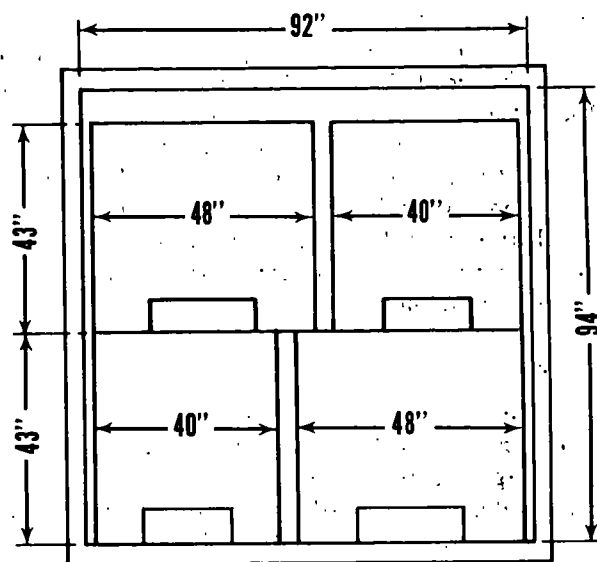
(2) The seal has been placed on the container, the seal number recorded, and the proper markings have been placed on the container in accordance with Military Standard Transportation and Movement Procedures (MILSTAMP).

e. *Pallet-Load Height.* Uniform pallet-load heights must be used to obtain maximum utilization of container cube when palletized loads are placed in containers. Better cargo cube can be obtained by using a pallet-load height of 43 inches instead of the 54-inch pallet-load height used in break-bulk shipments. The pallet-load height of 54 inches is too high for double stacking in a container and results in the loss of valuable cargo cube. Figure 9-3 illustrates how better cargo cube can be obtained by using the 43-inch load-height than by using the 54-inch load-height.

UTILIZED LOADS



UNDERUTILIZED



OPTIMUM LOAD

Figure 9-3. Contrasting methods of loading palletized cargo.

9-9. Containerizable and Noncontainerizable Commodities

a. Containerizable Items. The items listed below are considered priority items that yield the maximum benefits afforded by container shipments and are considered over other types of cargo for containerization.

- (1) High value cargo; i.e., cargo with an average value of \$1 or more per pound of net weight.
- (2) Classified cargo or cargo where concealment is required.
- (3) Commissary resale and post exchange items.
- (4) Mail.
- (5) Fragile commodities, such as electronic components, tubes, radios, etc., requiring the extra protection afforded by container shipment.
- (6) Cargo that is particularly susceptible to pilferage, such as liquor and cigarettes.

b. Noncontainerizable Items. Generally the following items should not be considered for shipment in containers:

- (1) Bulk cargoes such as coal, grain, and certain construction materials.
- (2) Unitized loads in excess of 4,000 pounds in weight or 7 feet 9 inches in width.
- (3) Explosives and hazardous munitions

prohibited by US Coast Guard Regulation 108, Rules and Regulations for Military Explosives and Hazardous Munitions. Not all dangerous cargo is prohibited—only that class of explosives specifically prohibited by regulation, such as class II-J hazardous materials.

c. Containerized Ammunition. Success in a test of containerized shipments of ammunition in 1970 has led the Army to direct that a plan and concept of operation be developed for a "total system" technique of moving ammunition directly from plants and depots in CONUS to forward ammunition supply points (ASP) in overseas theaters. The test began with an over-the-road movement of 226 container loads of ammunition from various Army ammunition plants and a depot to the Naval Weapons Station, Concord, California, where they were loaded aboard a C-2 self-sustaining container ship and moved through Cam Rahn Bay, Vietnam, direct to base depots and users at inland ASP. In addition, 44 containers on chassis were transhipped to Qui Nhan aboard an Army discharge lighter and barge in a roll-on/roll-off operation. Containerized ammunition shipments are now confirmed as feasible and are expected to result in significant reductions in cargo damage and ship onloading and offloading time.

Section III. OPERATIONAL AND SAFE HANDLING PROCEDURES

9-10. Operational Procedures

a. Military Offloading Support. Agreements with commercial contractors may be made for terminal operations personnel from a terminal service company to provide offloading support by performing the tasks described below in certain foreign ports. In such agreements, the personnel involved should be given advance lectures and practical training by the contractor's representatives. One such stevedoring operation was designed around a three 8-hour shift work schedule.

(1) The "Stevedore Gang" was organized as follows:

(a) *Shift foreman—one per shift.* Usually he is an E-7 platoon sergeant. He is responsible for all gangs working on a particular shift. His position is generally on the pier; however, he periodically checks operations of personnel aboard the vessels.

(b) *Gange foremen—one per working gang.* Usually this foreman is an E-5 or E-6 sergeant who is responsible for effective overall supervision of a gang working a particular crane. The gang foreman usually positions himself aboard the vessel with the three deck-men under his control.

(c) *Deckmen—three per gang.* These personnel, of E-3 or E-4 rank, work aboard the vessel under a particular crane. Their duties include the unlashng and unlocking of containers and pontons and vice versa.

(d) *Piermen—three per gang.* These personnel, of E-3 or E-4 rank, work under a particular crane on the pier. Their primary duty is to lock containers to the trailer chassis or to unlock containers from the trailer chassis as the containers are being loaded or unloaded.

(e) *Signalman—one per gang.* This individual, of E-3 or E-4 rank, is positioned on the pier working under a particular crane. He is responsible for giving proper signals to the crane operator to enable him to maneuver the crane spreader bars into position to pick containers off the trailer chassis or to properly position containers from the ship onto the trailer chassis.

(f) *Checker—one per gang.* This man, of E-3 or E-4 rank, has one of the most responsible positions in the entire operation. He controls the paperwork which is basically a preplanned listing of containers by number and sequence to be off-loaded and loaded onto the vessel being worked. The checker insures that personnel on deck and

the crane operator know the sequence of loading and offloading. He also informs the truck drivers of the yard position where the containers must be delivered and where to pick up containers for backloading. He maintains an accurate record of container numbers, truck chassis numbers, temperatures of refrigerated containers, and any discrepancies noted concerning the containers.

(g) *Stop-go lightman—one per shift.* This man is required only when working a self-sustaining vessel. This individual, of E-3 or E-4 rank, is positioned in a cubicle near the bridge of the vessel. He controls a green and red signal light that is observed by each of the two ship crane operators when both ship cranes are working simultaneously. His responsibility is to insure that only one crane is outboard of the vessel at any one time. This is done to prevent the possibility of capsizing the vessel.

(2) A maximum of four gangs can be worked during a particular shift—two per shore crane and two per ship crane. Sometimes operations are planned so that containers can be loaded or unloaded directly from one vessel to the other. This requires a highly coordinated effort especially when some containers must be delivered to and picked up from the yard during the same operation.

(3) Generally, there are two commercial supervisors working along with the military personnel during an operation. They constantly check all phases of the operations and give timely advice and assistance to the military personnel.

b. Military Transporting of Containers. Containers may be transported to their final destination using military equipment and personnel after they have been offloaded in a foreign country. (In one agreement, an Army Transportation Group (Truck) used M52 tractors to pull M127 semitrailers on commercial chassis with their containers from MSC contract ships.)

9-11. Safe Handling Procedures

a. Formulation. Safety procedures for handling containers are being formulated by the International Organization for Standardization (ISO). A proposal indicating procedures for the safe handling of containers has been submitted to the ISO by Sveriges Standardiseringskommission (Swedish Standards Commission). The proposal is still being considered by the ISO and has already been reviewed by the USA Committee for the ISO Technical Committee 104 (the USA

Committee includes representatives from the Department of Defense, the Maritime Administration of the Department of Commerce, and the Bureau of Labor Standards of the Department of Labor). The Swedish proposal as modified by USA Committee recommendations is presented in *b* through *f* below. It is emphasized however, that neither the Swedish proposal nor the USA Committee recommendations have as yet received formal acceptance by the ISO. They are included here for the sole purpose of providing interim guidance to military personnel handling containers, pending universal agreement in this area.

The purpose is to help prevent accidents to persons and damage to freight containers. Upon formal acceptance by the ISO of a document specifying international container handling standards, a change to this manual will be issued to reflect this document.

b. Load Considerations. Goods should be firmly secured within the container, especially bearing in mind the forces imposed upon a container during transport by truck, rail, air, or ship; rolling action can tilt a container up to 30° from the horizontal (fig 9-4).



Figure 9-4. Rolling of a container ship.

(1) The weight of cargo stowed in the container must not exceed that for which the container was designed, as indicated on the container, or the lesser weight required to keep the gross within the limit imposed by the particular mode of transportation to be employed.

(2) The actual weight of each loaded container (payload plus tare weight) must be made available to persons responsible for the physical handling of loaded containers.

(3) National and international regulations covering packaging, labeling, compatibility, and manifesting of hazardous goods must be followed when loading and documenting containerized shipments. One label of the type prescribed by the

United Nations for individual packages within the container must also be applied to the outside rear of the container and the shipment date shown thereon.

(4) When the nature of the load makes it necessary to place its center of gravity a distance of more than 10 percent of the container's length or width from the container's center of gravity when empty, this must be indicated on documents made available to all concerned with handling and transporting it.

(5) The weight of load must be distributed over the entire length and width of the container but in no case will the concentration of weight in any 10 linear feet exceed 25,000 pounds or the

maximum allowable load, whichever is less. If necessary, the load must be supported on beams of sufficient strength and length to meet these requirements.

c. Lifting.

(1) *Top lifting.* Top corner fittings are the

recommended lifting points for all types of containers which have them. The equipment should therefore be designed for lifting from these fittings and should be properly attached to them (figs 9-5(1) through (3), 9-6, and 9-7).

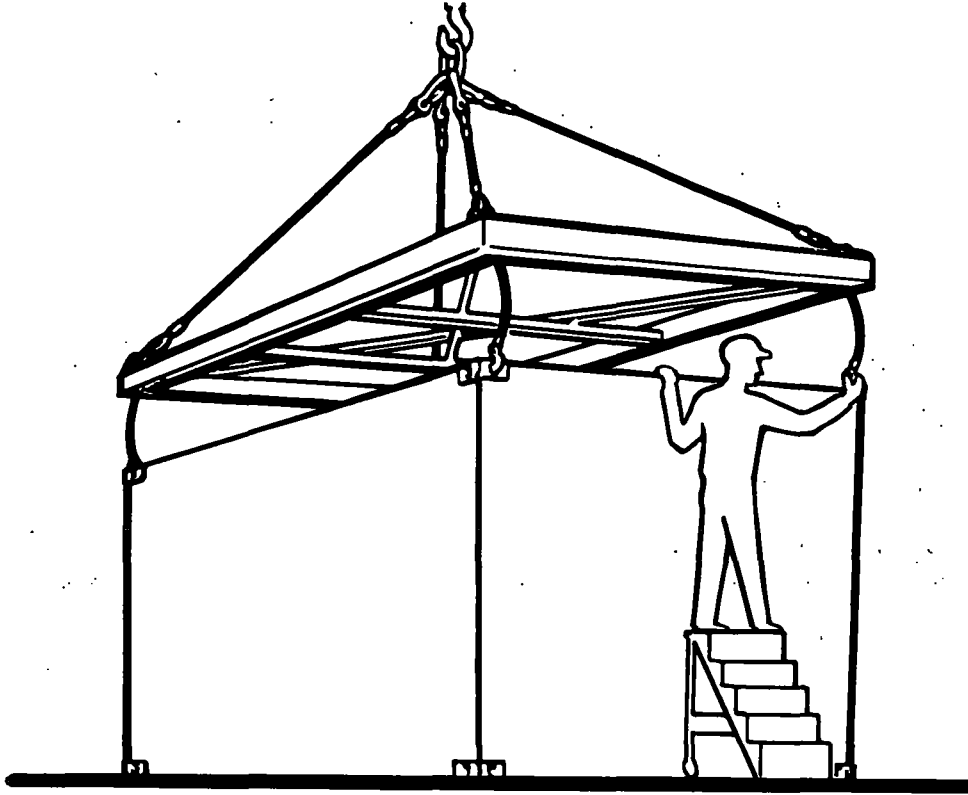


Figure 9-5(1). Attaching lifting equipment.

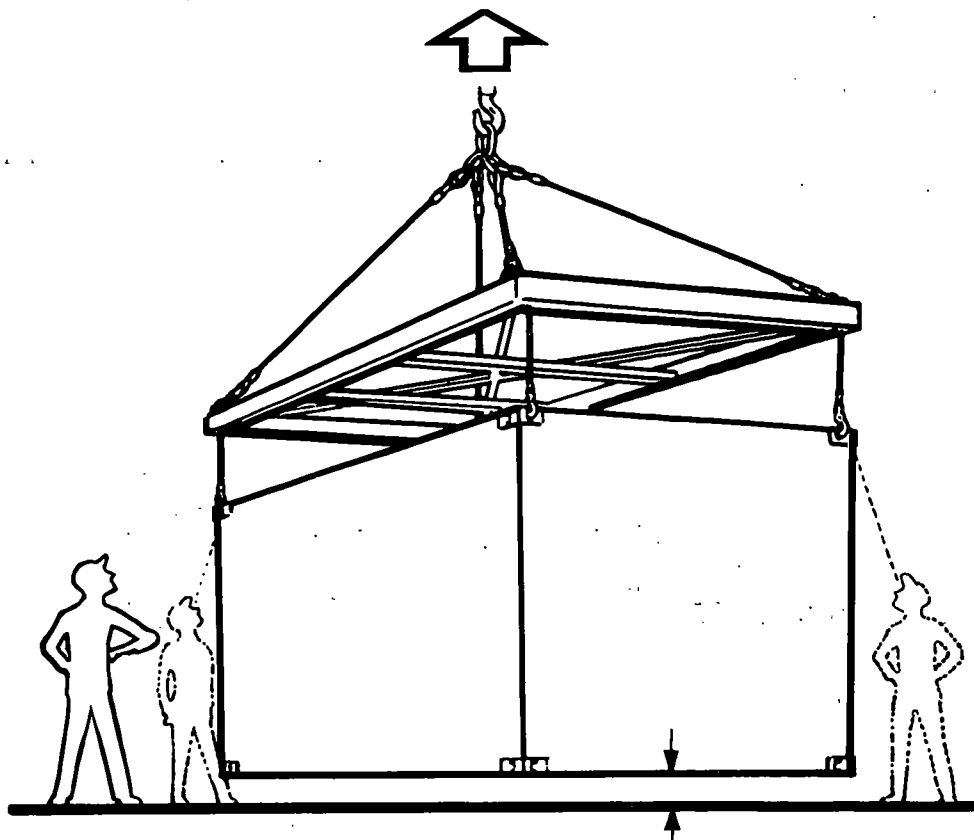


Figure 9-5(2). Checking attachments when just clear of ground.

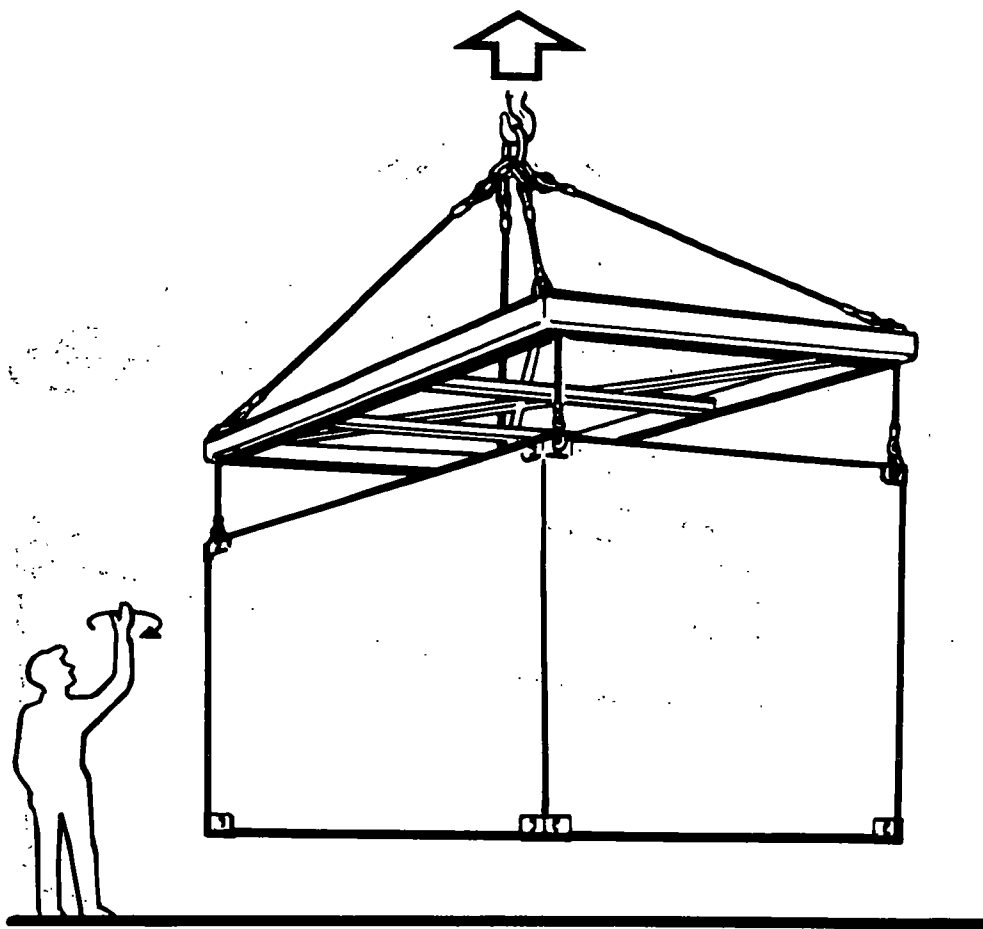


Figure 9-5(3). Lifting.

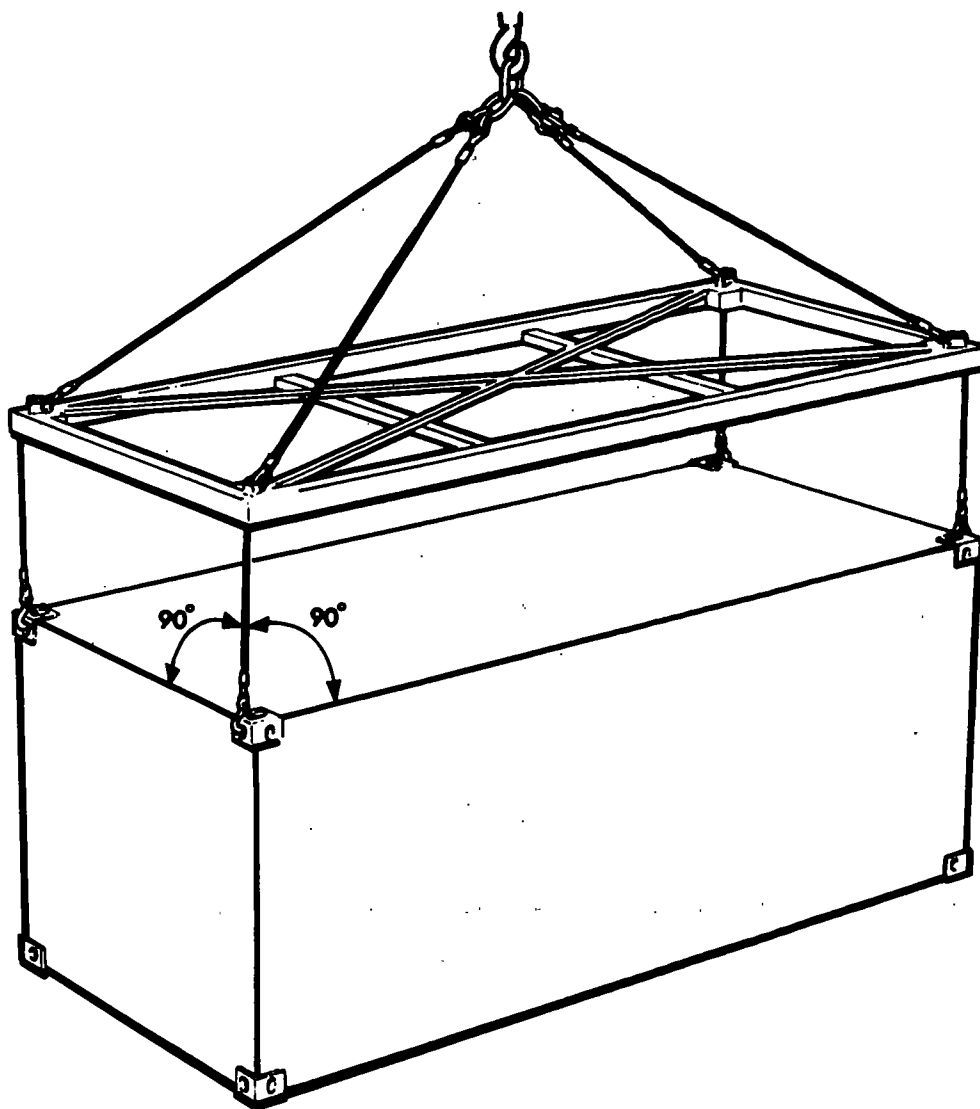


Figure 9-6. Correct lifting of container from top corner fittings.

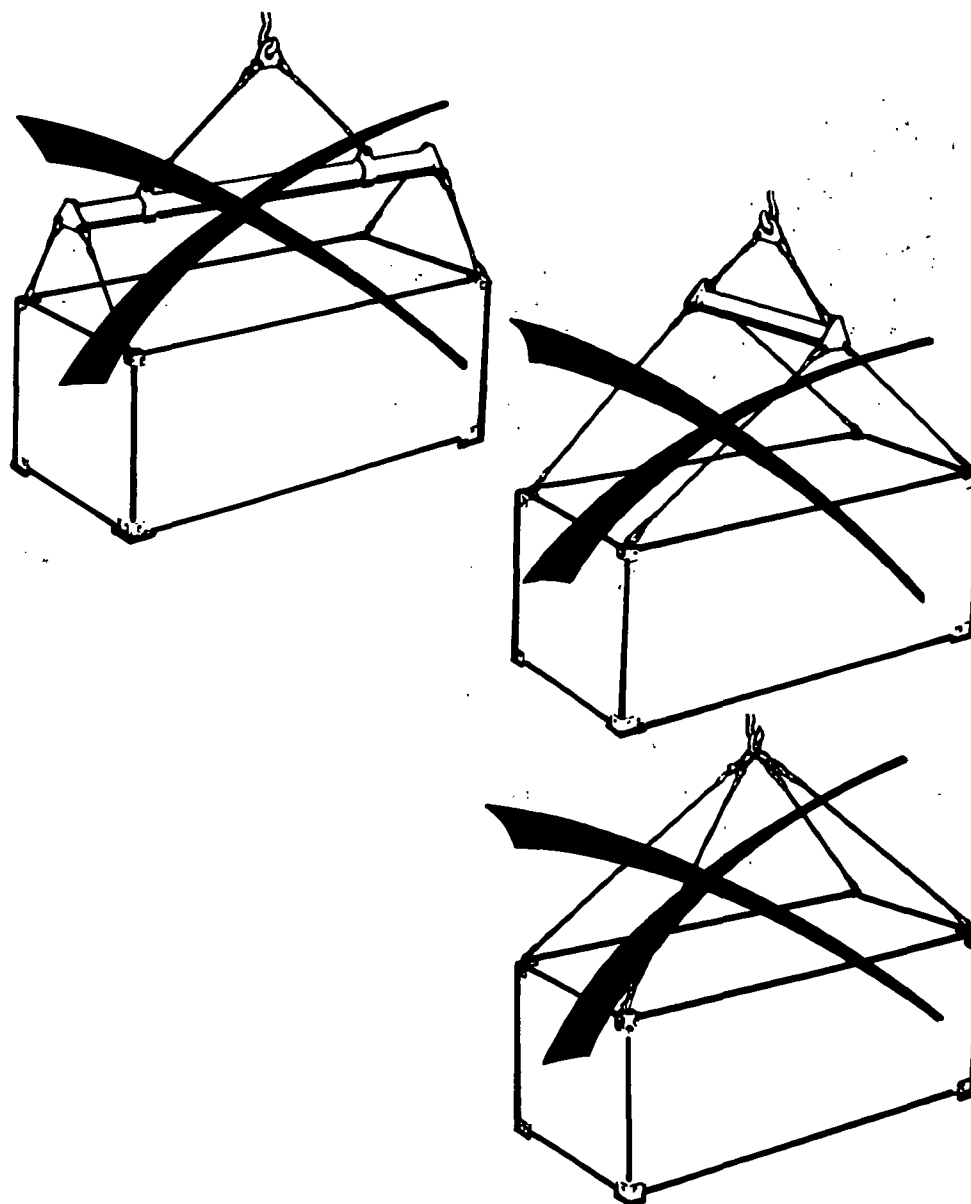


Figure 9-7. Incorrect lifting methods.

(a) Containers 20 feet or more in length should be lifted only by the following types of equipment:

1. Rectangular spreader with twist locks (fig 9-8).

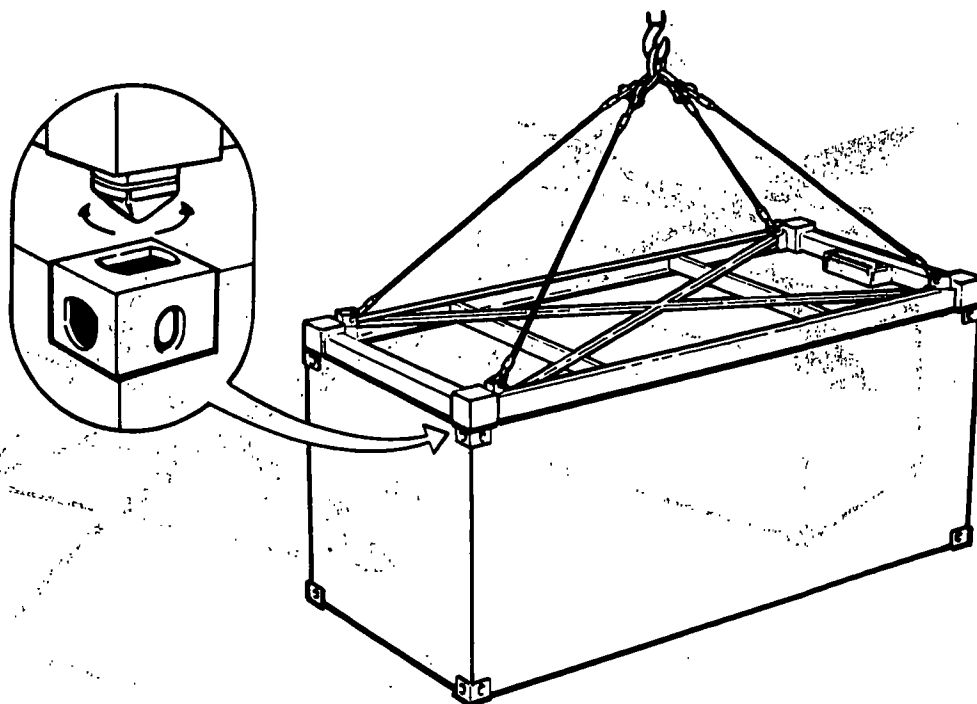


Figure 9-8. Vertical lift, using twist locks.

2. Rectangular spreader with pendant hooks or shackles, with the lifting force always applied vertically (fig 9-9 and 9-10).

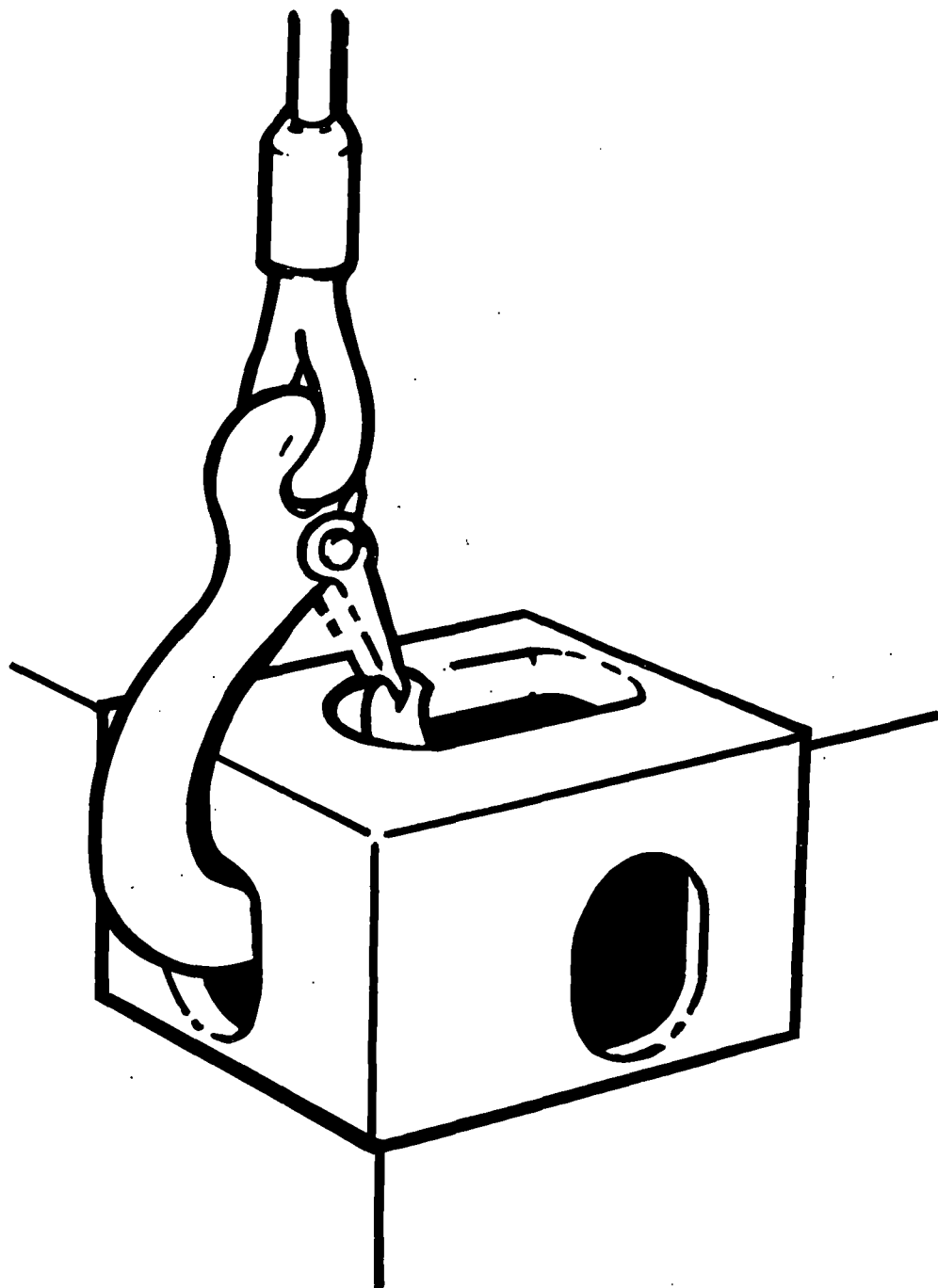


Figure 9-9. Example of hook attachment.

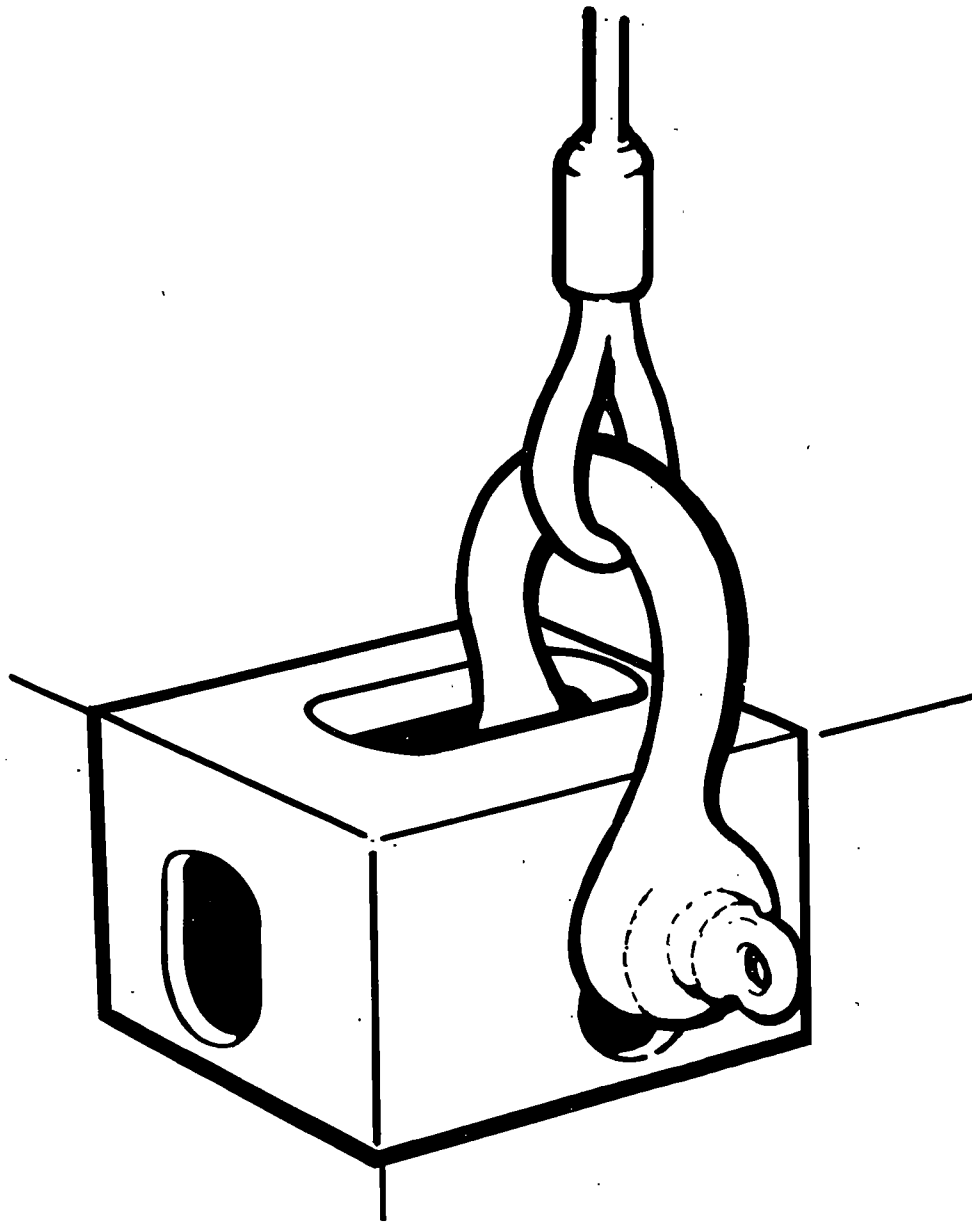


Figure 9-10. Example of shackle attachment

3. A bridle arrangement having a longitudinal beam the length of the container and two compression beams the width of the con-

tainer, with pendant hooks or shackles which apply a vertical lift to the corner fittings (fig 9-11).

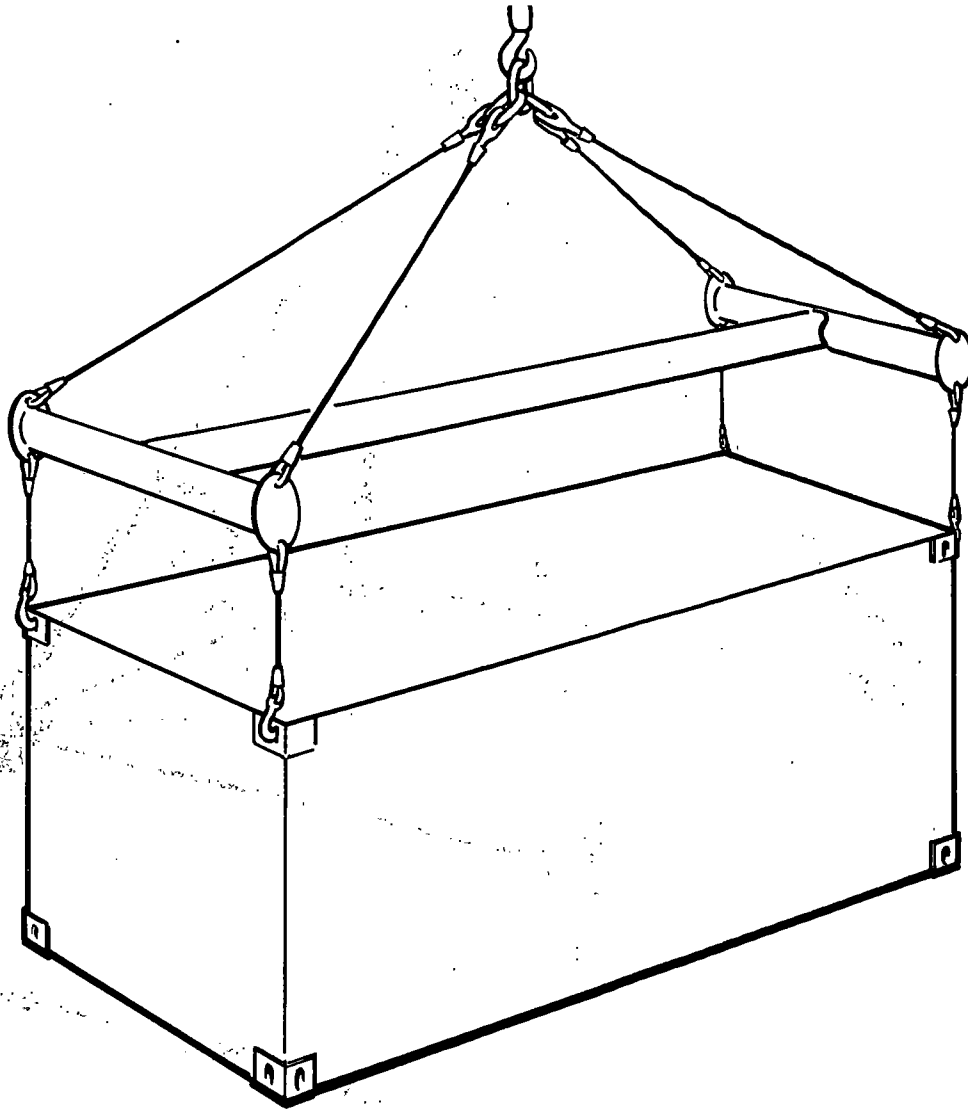


Figure 9-11. Permissible bridle lifting device with longitudinal and compression beams.

(b) Containers of 10 feet or less in length (including CONEXes) may be lifted by hooks or shackles on a four-legged bridle provided the legs

of the bridle make angles of not less than 60° to the horizontal (fig 9-12).

THE FOLLOWING INFORMATION IS FOR INFORMATION ONLY

TO BE USED IN THE FIELD ONLY

FOR THE USE OF THE FIELD ONLY

FOR THE USE OF THE FIELD ONLY

FOR THE USE OF THE FIELD ONLY

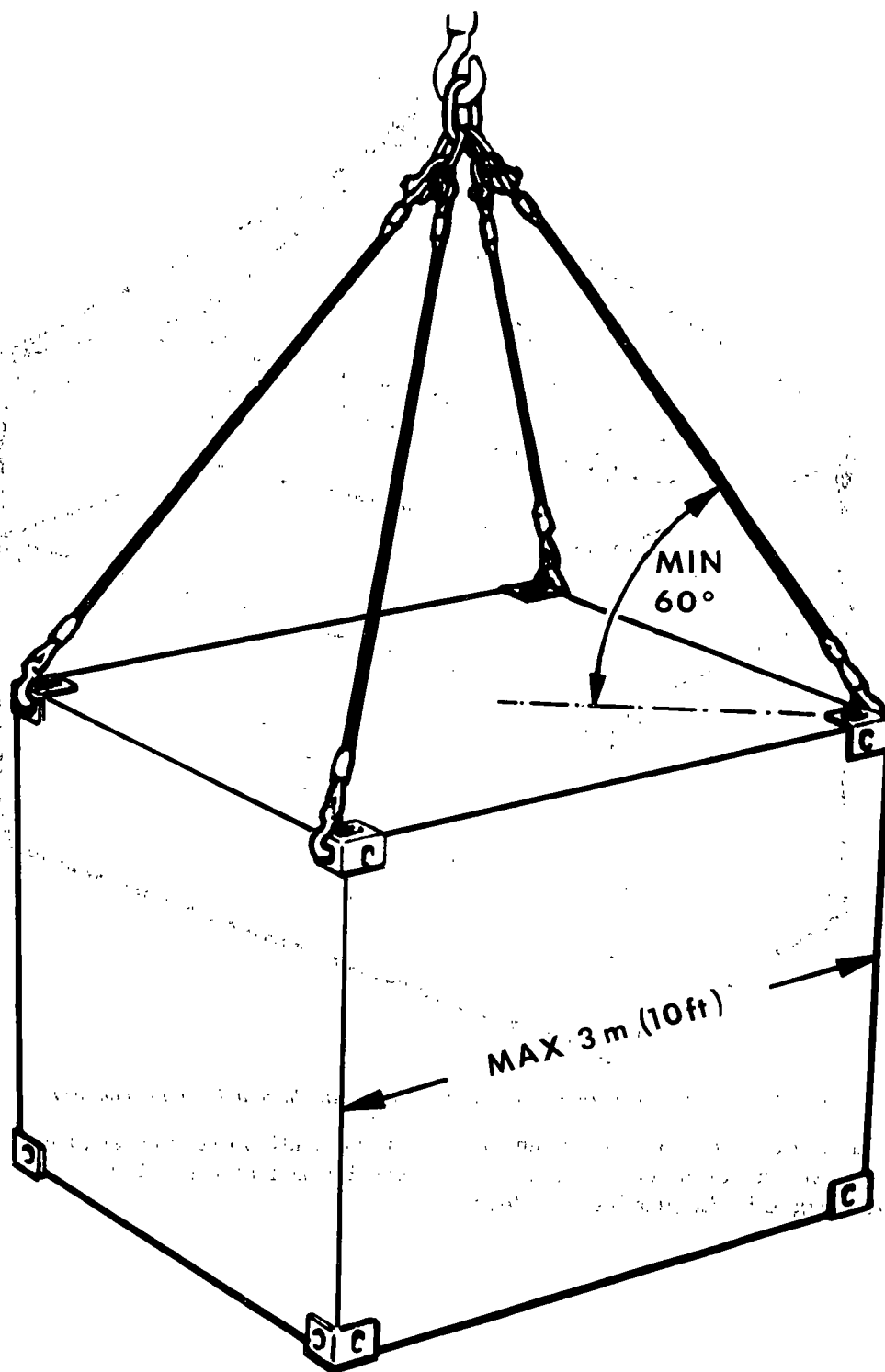


Figure 9-12. Permissible lifting angles for 10-foot and under containers.

(c) Containers are not designed or constructed to withstand forces imposed by lifting while coupled unless eight-point engagement is employed; i.e., all eight top corner fittings are used as lifting points.

(d) Hooks and shackles used must not damage corner fittings.

(2) *Bottom lifting.* Containers may be lifted by the bottom corner fittings using hooks or special attaching devices (fig 9-13) provided—

(a) Sling legs terminate at one or two lateral spreaders (above the roof line of the container) of sufficient length to prevent the sling legs from making contact with the container. Sling legs must be long enough so that the angle

of each leg is not less than 30° from the horizontal.

(b) Attachment devices are designed so that the lifting force is not exerted more than $1\frac{1}{2}$ inches away from the face of the corner fitting.

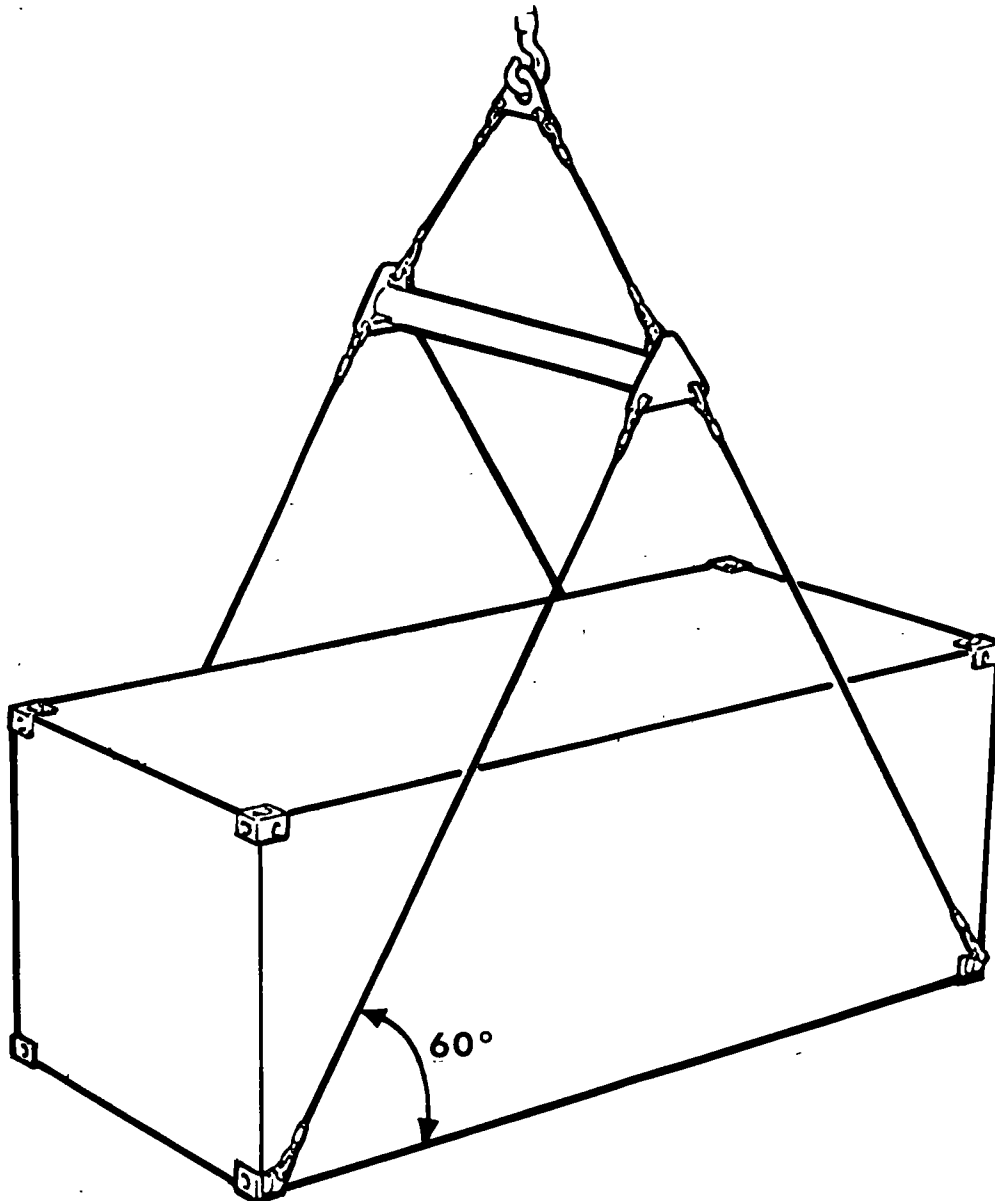


Figure 9-13. Lifting from bottom corners.

(3) *Other methods of handling.* Containers that are to be handled by any other method than lifting from the corner fittings will be so designed and fitted with special features, such as forklift pockets, recesses for straddle carriers, or grapple holds. Appropriate handling equipment must always be used; all personnel engaged in handling operations should receive instructions concerning the appropriate methods to use.

(a) *Handling with forklift truck.* Forks must extend the whole width of the container. The load capacity of the truck should be enough to handle the container when the center of gravity is on the half length of the forks. Figures 9-14(1) through 9-14(3) illustrate correct and incorrect handling with a forklift truck.

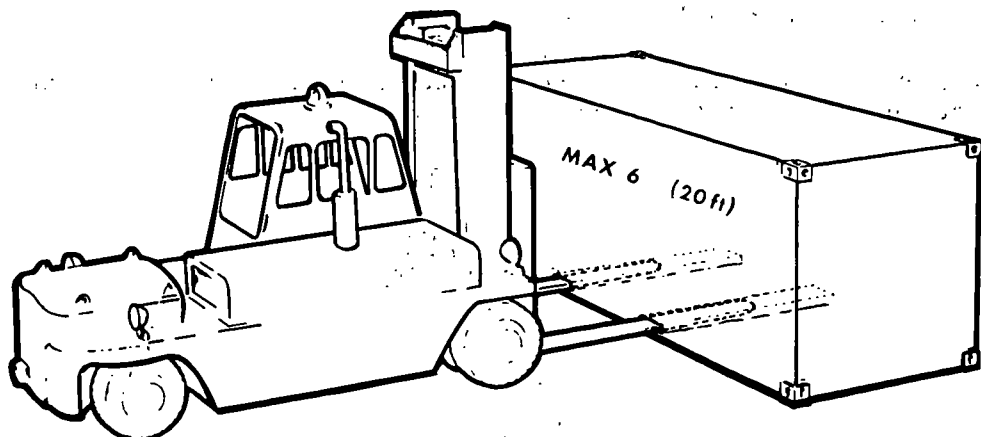


Figure 9-14(1). Correct handling with forklift truck.

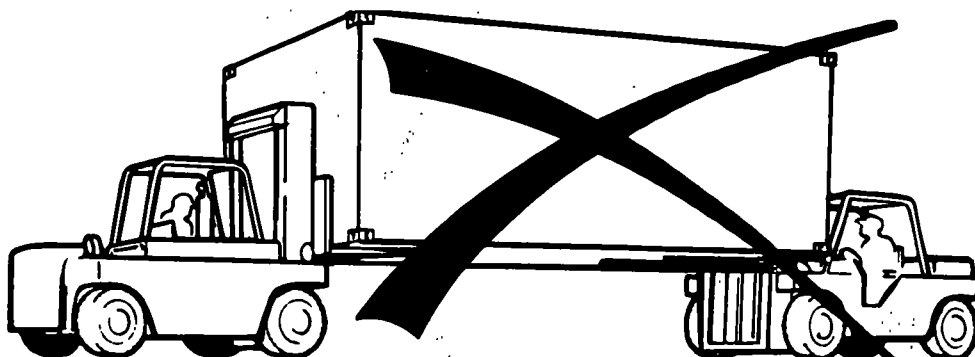


Figure 9-14(2). Incorrect handling with forklift trucks.

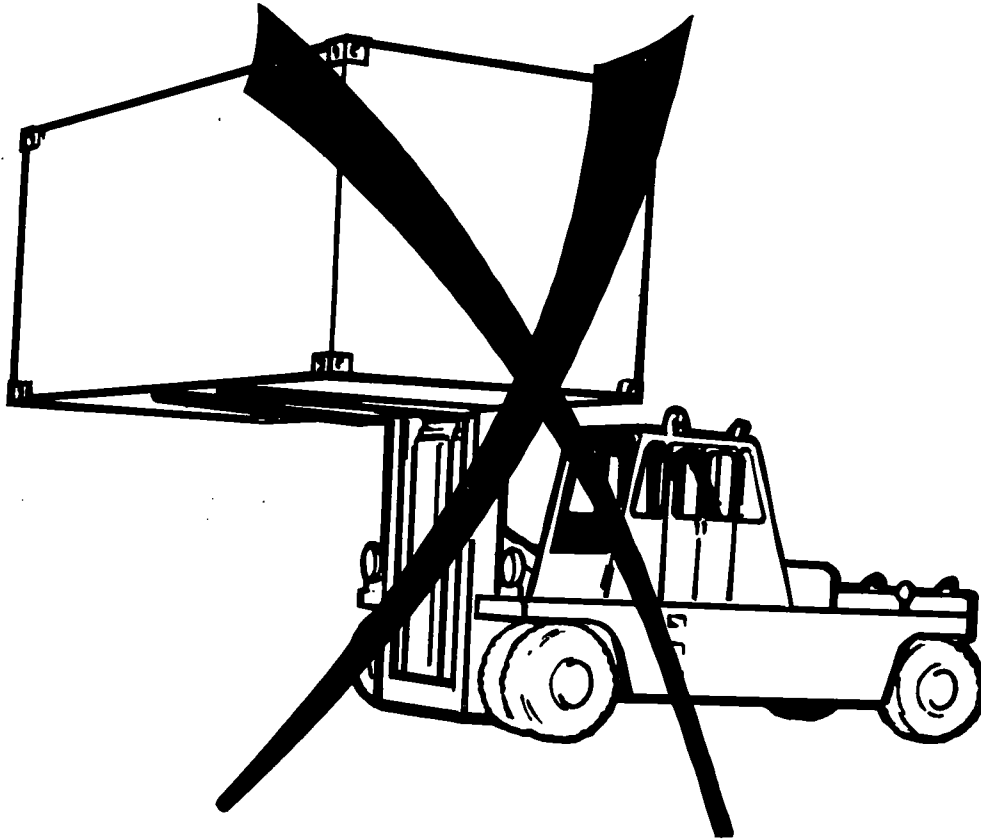


Figure 9-14(3). *Incorrect handling with forklift truck.*

(b) *Handling with straddle carrier.* When lifting with this device personnel should insure

that recesses are both available and used on the lifted containers (fig 9-15(1) and 9-15(2)).

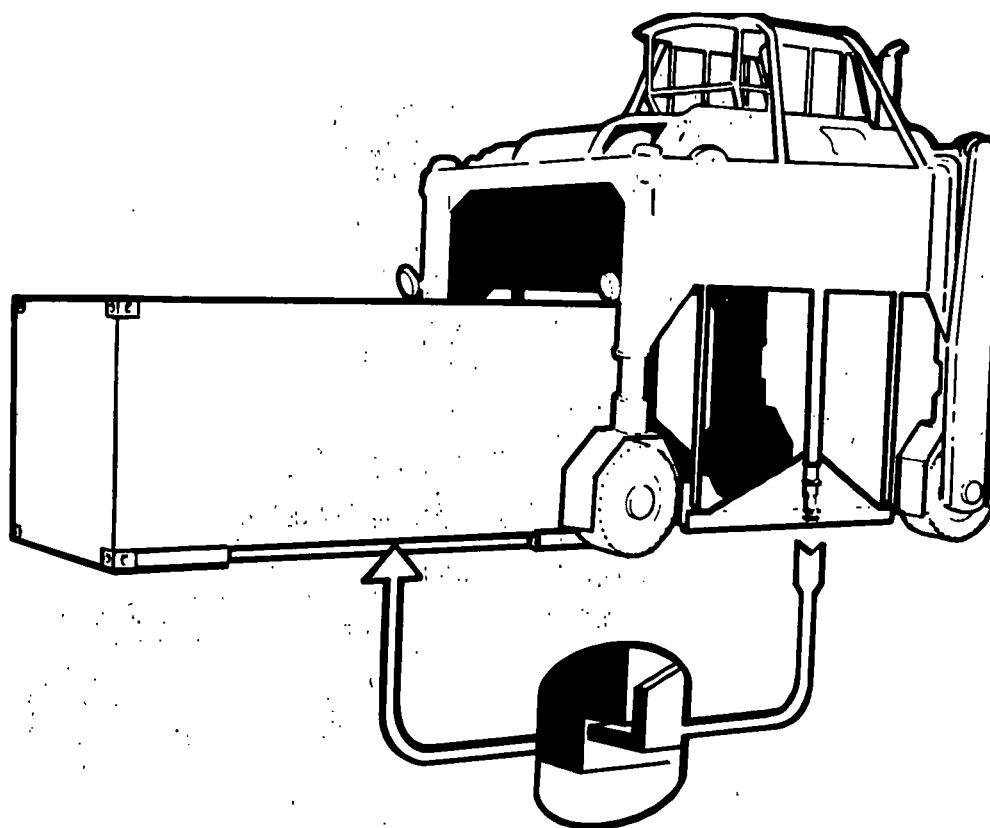


Figure 9-15(1). Correct handling of containers with a straddle carrier.

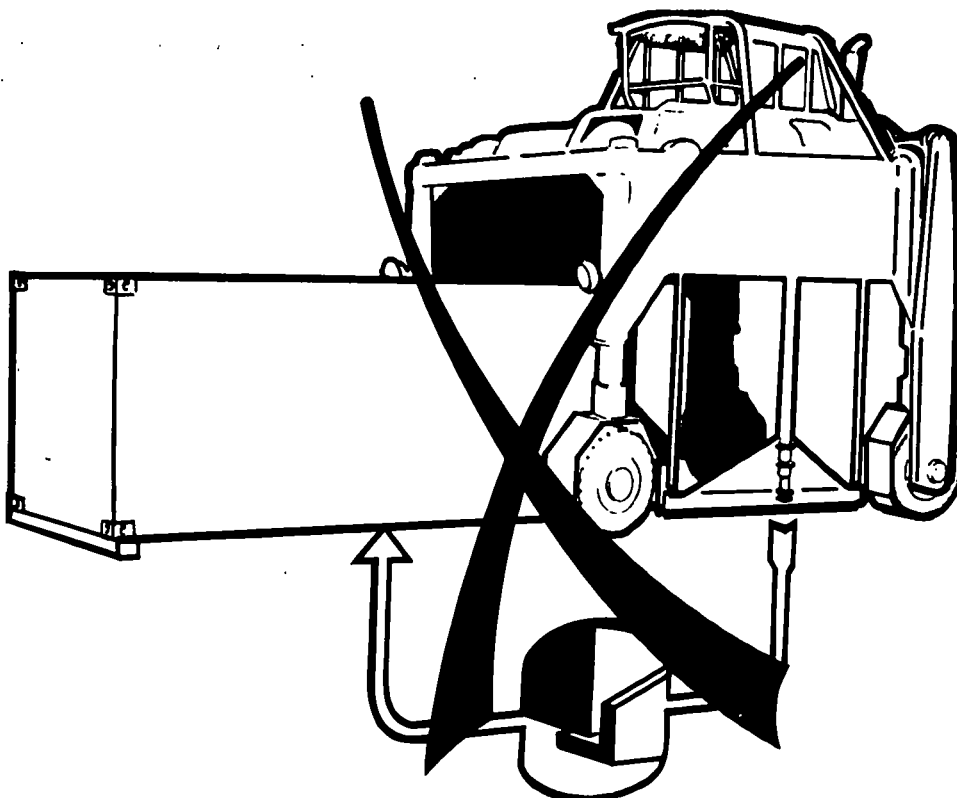


Figure 9-15(2). Incorrect handling with a straddle carrier.

(c) *Handling with grapple lift.* Proper recesses should be available and used on the lifted containers (fig 9-16).

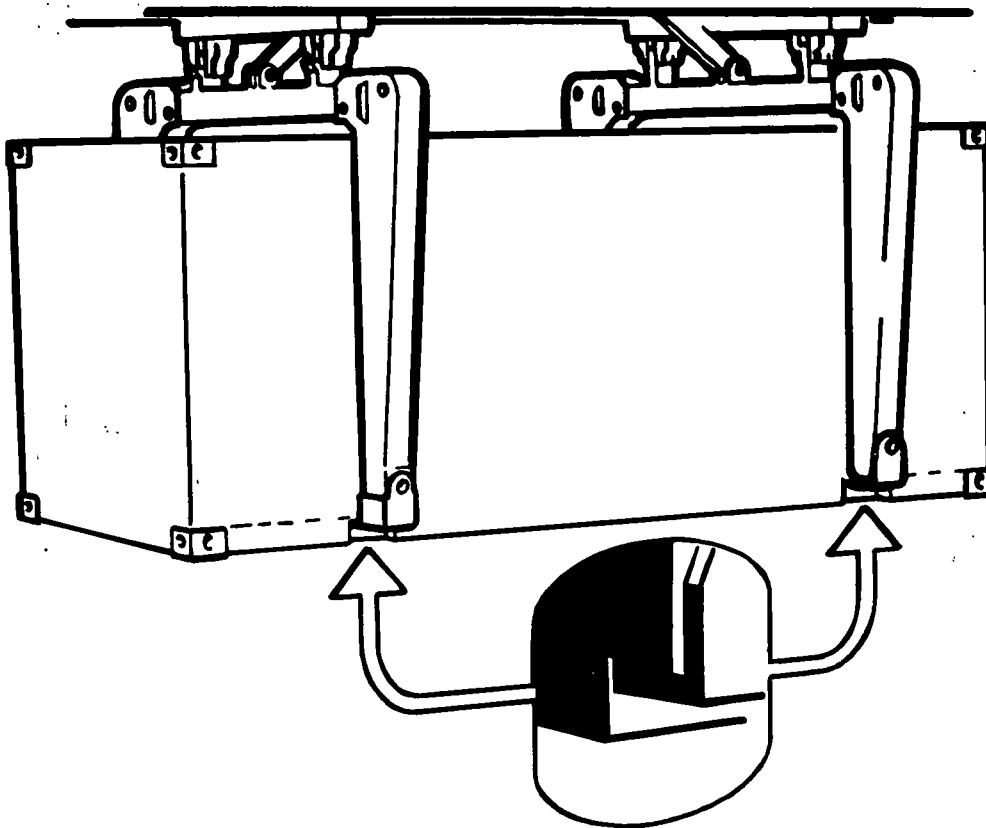


Figure 9-16. Correct handling of container by grapple lift.

d. *Stacking Containers.* When not in transit, containers are often stacked on piers, in transfer facilities, or in other storage areas. Proper safety precautions are also required here to prevent accidents and damage.

(1) *Landing surface.* When landing a container on the ground or pier in a terminal area, a firm horizontal surface or necessary blocking must be provided so that the container can be supported by its four bottom corner fittings. There must be no projections on the landing surface which could possibly damage the bottom structure of the container.

(2) *Stacking.* When stacking, particular attention must be paid to the alignment of top and bottom corner fittings of superimposed containers. Variance from exactly vertical stacking should be restricted to 1½ inches (38mm) in the longitudinal direction and 1 inch (25mm) in the lateral direction.

e. *Securing the Container.* When other special arrangements are not made, twist locks or similar devices should be used to secure all four bottom corner fittings (fig 9-17 through 9-19).

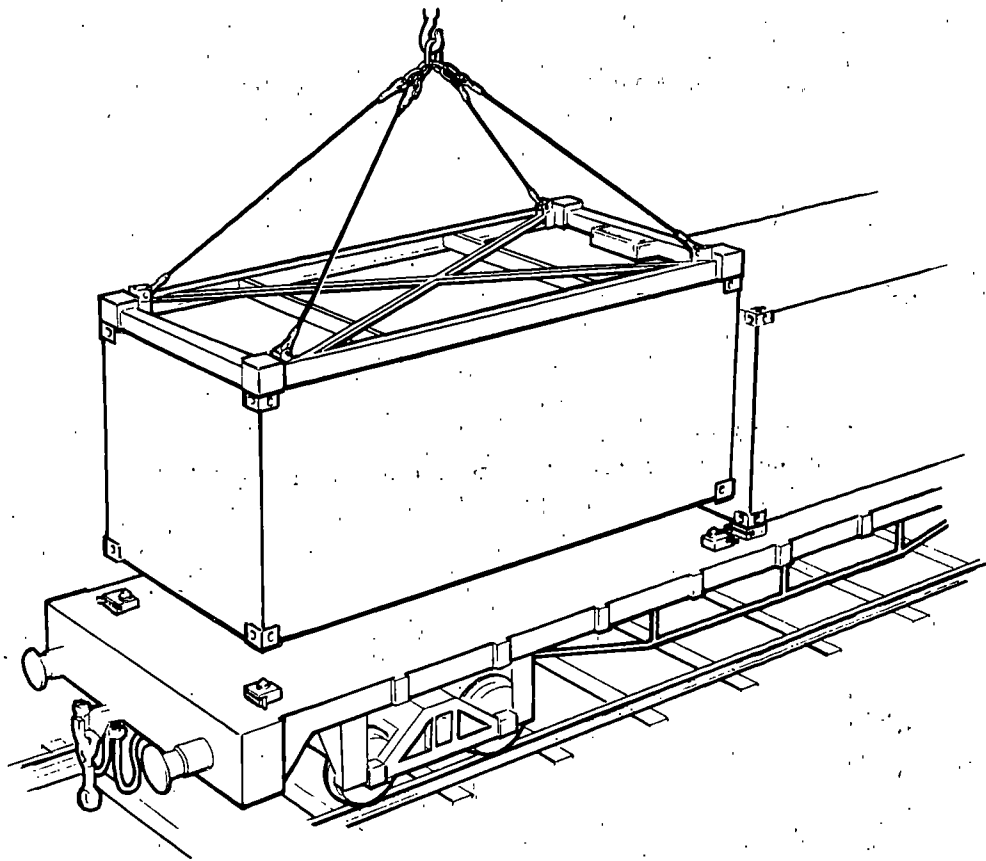


Figure 9-17. Securing container of railcar.

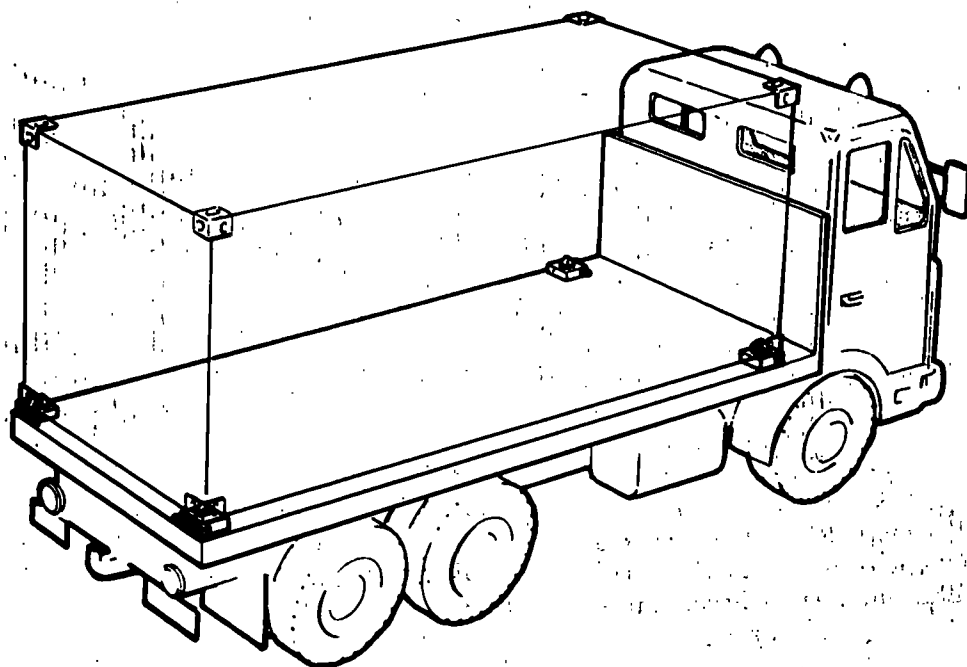


Figure 9-18. Securing container on truck.



Figure 9-19. Example of a locking device.

f. Lashing. Sometimes lashings are used as a substitute for, or in addition to, twist locks. This is especially true on the decks of LCU, LCM, or LARC, the rolling of which can exert severe strains on containers. When lashing is used it is done from all top corner fittings of the containers if they are sitting on top of dunnage on deck and from all bottom corner fittings if they are sitting on MILVAN chassis. In either case, the lashings

may or may not be crisscrossed, depending on the deck fittings and/or space available. Figures 9-20 and 9-21 show examples of crisscrossing. If not crisscrossed, the lashings should extend off to the sides of the chassis and/or container as in figures 9-22 and 9-23. These techniques provide good protection against upward, side-to-side, forward, and rear movement.

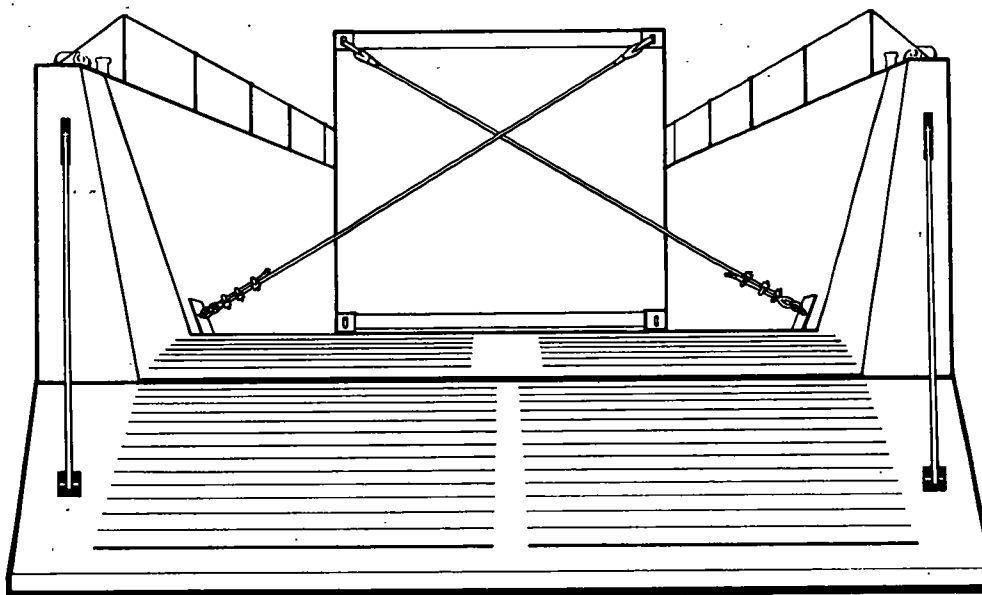


Figure 9-20. Crisscross lashing of container.

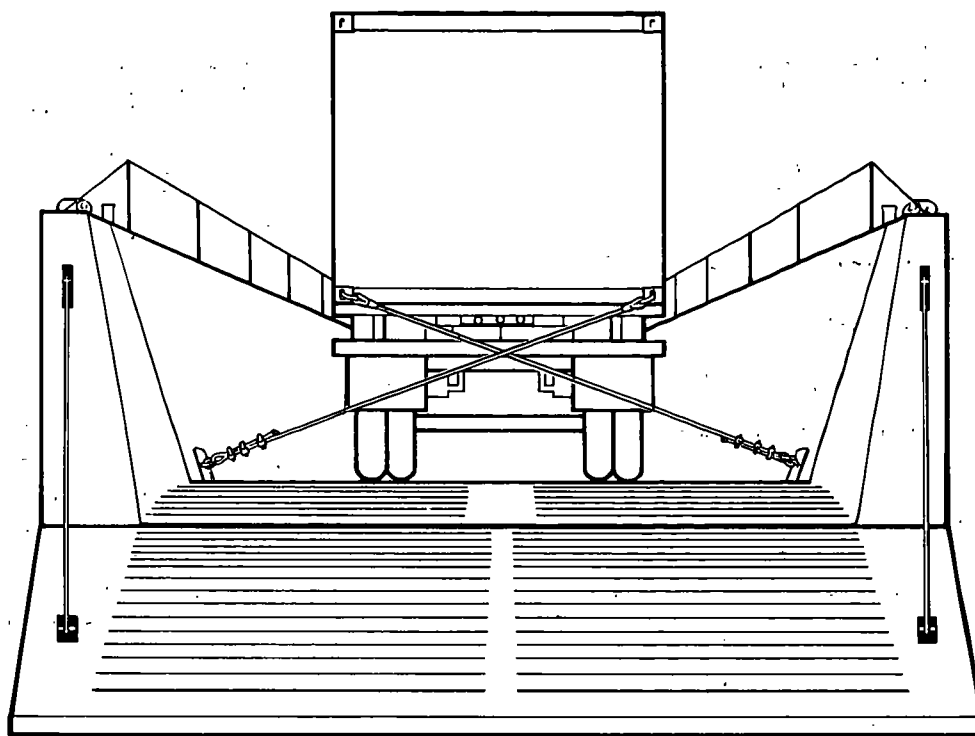


Figure 9-21. Crisscross lashing of container and chassis.

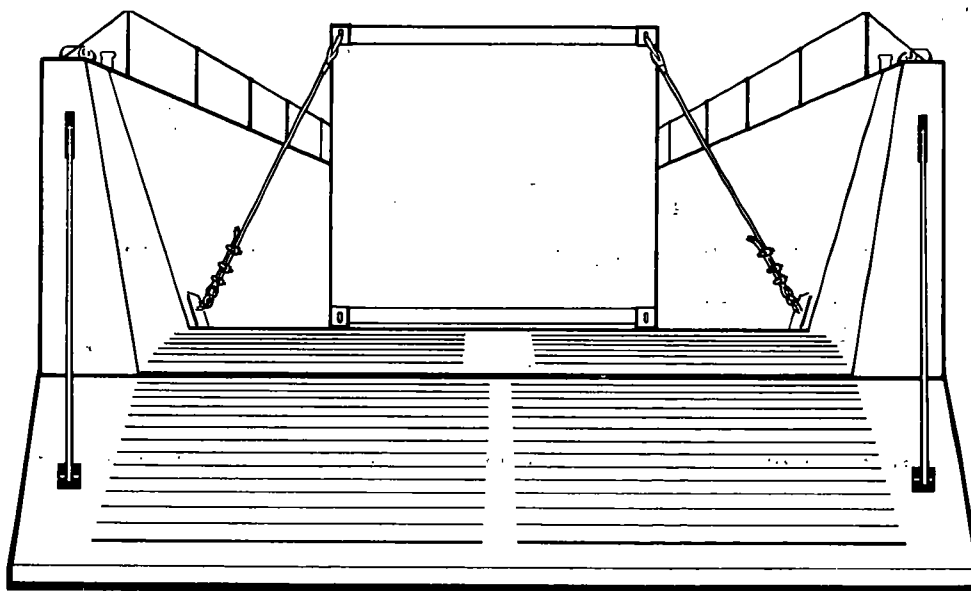


Figure 9-22. Sideward lashing of container.

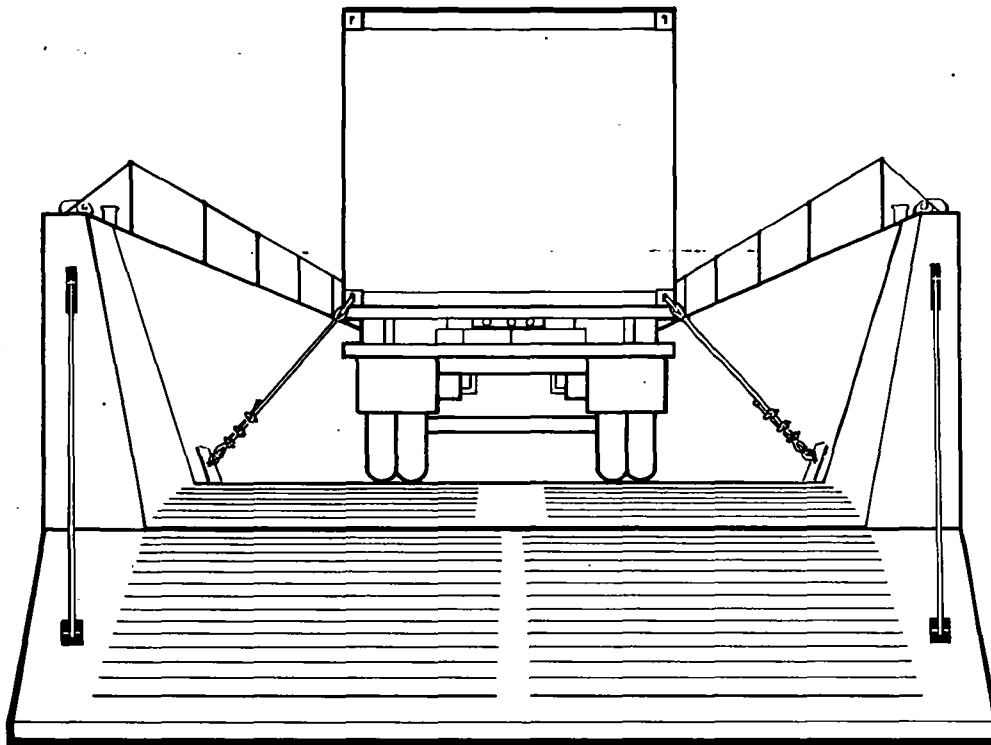


Figure 9-23. Sideward lashing of container and chassis.

Section IV. MILSTAMP REQUIREMENTS FOR MILVAN / SEAVAN SERVICE

9-12. MILSTAMP Functions

MILSTAMP (military standard transportation and movement procedures) is not designed to tell when to use SEAVAN service; this is a traffic management function. However, once this service has been selected, MILSTAMP provides the necessary information for movement through all segments of the pipeline as well as information for reporting on the movement.

9-13. MILSTAMP Processing Documentation Requirements

All shipments moving into and through the

Defense Transportation System (DTS) in commercial or Government-owned (or leased) shipping containers which are moved by ocean transportation without bogie wheels attached are processed and documented according to the provisions of section IV, chapter 3, DOD Regulation 4500.32-R (MILSTAMP). Shipments moving via roll-on/roll-off service are processed and documented in accordance with section I, chapter 3, MILSTAMP.

PART THREE
CARGO HANDLING IN LOGISTICS OVER-THE-SHORE OPERATIONS
CHAPTER 10
INTRODUCTION

10-1. General

Part three deals with cargo handling in logistics over-the-shore (LOTS) operations. It instructs terminal service personnel in discharging from vessels to lighters in the stream and in unloading landing craft at the beach and amphibians at inland transfer points. It covers the handling of general, unitized, and special cargo; the movement of personnel; and the use of special cargo handling equipment.

10-2. Employment of LOTS Operations

LOTS operations may be instituted to supplement or increase the tonnage capabilities of an

existing port, replace the tonnage capacity of a port made untenable by enemy action, relieve congested lines of communication, or reduce the land transportation required to support combat forces. LOTS operations may be conducted jointly in support of other Department of Defense agencies for resupply missions, jointly following amphibious assault in support of a landing force, unilaterally in support of land (air, airborne, or amphibious) forces, or unilaterally to provide alternate terminal facilities or to establish terminal support where commercial facilities do not exist.

CHAPTER 11

LOADING LIGHTERS AT SHIPSIDE

11-1. General

a. The function of receiving and securing cargo aboard lighters is the responsibility of the cargo handling unit which is working the ship. However, when sea conditions or other operating factors preclude the safe transfer of personnel from one vessel to another, this function is customarily accomplished by the lighter crew. Due to the small cargo capacity of the LARC-V and LARC-XV, this function is usually accomplished by the lighter crew, even in calm weather.

b. Personnel must take the same precautions in handling such special type cargo as ammunition, vehicles, and heavy lifts as they would aboard ship. Dunnage, chocking, and lashing are required.

11-2. Loading Procedure

a. The general rules listed below apply as guidelines to be followed in receiving, stowing, and securing cargo aboard lighters:

(1) Work lighters on the lee side of the vessel if possible.

(2) Rig spring lines and mooring lines so that the lighters are positioned directly below the ship's outboard booms. The importance of proper mooring cannot be overemphasized because of the violent movement which passing ships and rough seas can cause for smaller lighters at shipside.

(3) When possible, make up unitized loads of small items which can be unhooked and left in the lighter.

(4) Attach two or more taglines to each draft of cargo in order to minimize swinging.

(5) In rough water, land the draft at the crest of the wave and slack off the runner immediately to prevent the draft from being hoisted as the lighter falls in the trough of the wave.

(6) Do not allow personnel to stand in the cargo space when landing drafts in small amphibians or landing craft.

b. In most offshore operations it is not necessary to plan stowage for the lighter, but care should be taken not to overload it. Table 11-1 gives the cargo capacities of the most common lighters found in the military inventory.

Table 11.1 Characteristics and Capabilities of Army Lighters

	LCM(8)	LCU (1466 Class)		LARC V	LARC XV	LARC LX	BC 7005	BC 231A	BK 7001
		Main	Forward						
Cargo space (inches)									
Length	513	624	264	192	288	459	1,200	1,320	948
Width	174	354	172	116	120	164	312	324	240
Height	80	54	—	29	38	74	—	—	—
Allowable cargo load (long tons)	53.5	150.1	—	4.4	13.3	53.5	570.0	585.0	130
Number of CONEX (single tier)									
Type I	20	56	—	4	10	18	96	102	54
Type II	10	24	—	2	4	8	48	51	27
Number of palletized load (single tier — stevedore pallets)	21	56	—	4	12	18	100	108	65

CHAPTER 12

DISCHARGING LIGHTERS AT THE BEACH

Section I. LANDING CRAFT

12-1. Beach Preparation

a. At each LOTS discharge point, the beach is the area that requires the closest attention and the greatest supervision. The success of a beach operation depends to a great extent on the efficiency of cargo operations on the beach. Supplies and equipment being brought to the beach should be kept moving across it and as far forward as the situation dictates. When sand beaches are used, it is usually necessary to build roadways to support the vehicles. Aircraft landing mat (steel planking), gravel, or similar material may be used, or water may be pumped onto or spread over the beach. Damp or wet sand has a greater bearing capacity than dry sand. If available, the class 30 assault trackway may be used as an expedient surfacing to enable vehicles to negotiate beaches, dunes, steep grades, or areas of low bearing capacity.

b. Transportation requirements for clearing personnel, supplies, and equipment from the beaches usually exceed available capabilities. Close planning and coordination are necessary to achieve maximum use of the allocated equipment. For efficient beach operations, the terrain should be gently rising and relatively clear. The surface should be firm with adequate drainage. For better traffic control, exits and entrance roads to the beach should be constructed when the situation permits.

c. A landing craft is properly beached when it is driven toward the beach until the forward portion of the hull is grounded and the ramp is resting on dry land or in less than a foot of water. After unloading has been completed, the craft must be able to return to sea under its own power. To meet the above requirements, the beach selected should have deep water close to shore; a firm bottom; minimum variations in tides, current, or surf; and a beach gradient ranging from 1:15 to 1:30. Such a gradient will rarely exist

in the area desired for ground operations. By using the bulldozers available to the terminal service company, dirt landing approaches may be prepared as the tide drops. This method is a field expedient that must be repeated each time the tide moves out.

d. Rough terrain cranes and forklifts are required at the shoreline to transfer cargo from landing craft to motor transportation.

(1) Unless protected for surf action, the sand will be washed from under the wheels of the rough terrain crane which will tip over when picking up a lift. Several field expedients are possible: the crane may be operated from a floating platform; a platform may be made from sandbags or some other material that will hold against the washing action of the surf; or a perforated splashboard may be used on the seaward side of the wheels to break surf action and retain sand under the wheels.

(2) Cranes should be protected from the corrosive action of salt water. A heavy coating of grease and frequent washing down with fresh water protects against this danger.

12-2. Clearing Cargo at the Beach

When amphibians are not used as lighterage, the terminal service company unloads cargo from landing craft and loads it into a clearance conveyance (fig 12-1). Clearance conveyances may be either air, rail, or truck. If cargo cannot be cleared immediately, it is transferred by motor transportation attached to the terminal commander to a temporary holding area. The cargo handling section can normally load cargo aboard clearance conveyances and unload cargo in the temporary holding area, but it does not have the capability to accomplish both and operate the temporary holding area without being augmented with additional personnel.

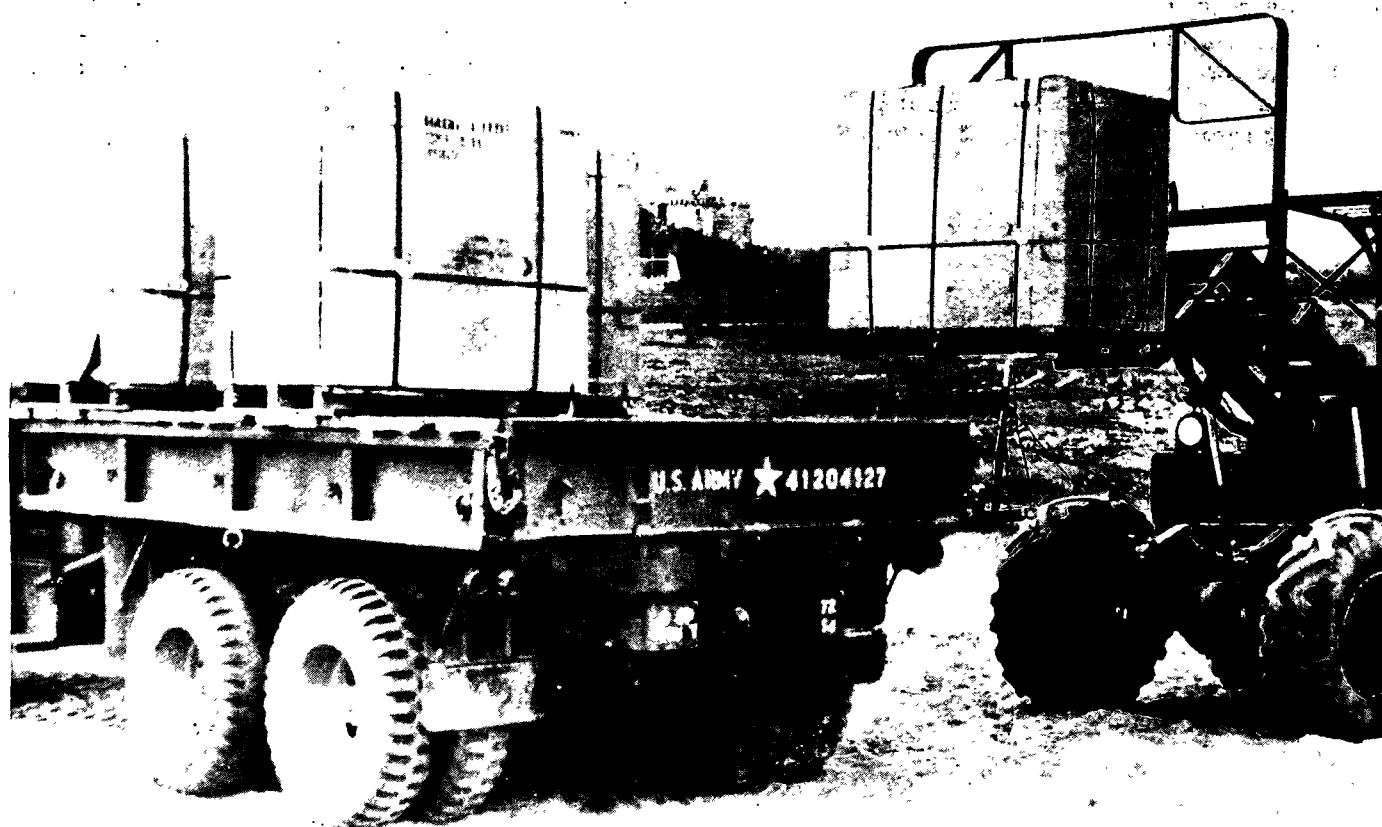


Figure 12-1. Loading cargo on a 2½-ton truck with a rough terrain forklift.

Section II. AMPHIBIANS

12-3. Beach Preparations

a. Minimum beach preparation is necessary to operate amphibians. The LARC can move easily over soft sand and, if necessary, over sharp coral. Because of the size of the tires, ground-bearing pressure can be reduced sufficiently to enable amphibians to traverse such extreme surfaces as rough coral.

b. The M6-, 8-, and 9-series aircraft landing mat may be used to improve both the beach area and the exit routes.

12-4. Entry and Exit Routes

a. Because cargo is unloaded some distance from the beach in amphibian employment, the length and depth of the beach is not as restrictive as when landing craft is employed. Amphibians should be allocated a separate portion of the beach. This along with separate entry and exit

points produces a more efficient operation and reduces accident potential.

b. Sufficient space should be provided for separate entrance and exit points at the waterline. Exit routes behind the beach must provide the same degree of traffic ability and should tie in with the road nets to the discharge areas. The road width for amphibians varies from 12 feet for one-way traffic to 65 feet for two-way traffic.

12-5. Discharge Areas

a. The commander of the amphibious unit does not make the final decision on the location of any discharge area, but he can recommend site selection and be of great help to the commander of the terminal unit responsible for laying out the area.

b. Discharge areas should be located far enough inland so that the cargo does not pile up on the

beach and must be adequately dispersed so that they will not present a lucrative target for enemy mass-destruction weapons. However, they should be as near to the beach as possible, because primarily amphibians are used to perform lighterage service. The shortest practicable land haul should be made by the amphibians.

c. The terminal unit is responsible for operating

the cargo discharge areas. Although the transfer or unloading of cargo is not the direct responsibility of the amphibious unit commander, he is involved in the security, speed, and safety with which these operations are performed. Speed of unloading must never jeopardize the safety of the vehicle or the individuals operating it.



PART FOUR
MOTOR TRANSPORT AND RAIL LOADING
CHAPTER 13
INTRODUCTION

13-1. General

The movement of cargo in a theater of operations often requires the use of all modes of transportation and a variety of materials handling equipment. Terminal service personnel may be employed at rail or inland water terminals, transfer points, in-transit storage areas, and depots, as well as at ocean terminals. They must therefore know cargo handling methods for loading and discharging trucks, trailers, and railcars, as well as vessels and lighters.

13-2. Basic Considerations

a. The same factors apply to cargo handling for rail and motor transport as for oceangoing vessels:

(1) Cargo must be loaded and stowed to prevent damage to the cargo and the conveyance.

(2) Safety standards must be rigidly observed during all cargo handling operations.

(3) Maximum utilization should be made of the load carrying capacity of each conveyance.

(4) Cargo should be loaded so that it may be unloaded with the greatest possible speed.

(5) The conveyance should be loaded for discharge by destination whenever possible.

b. Land transport must be loaded within the weight and size limitations of tunnels, bridges, curves, viaducts, or other obstructions along the route.

c. Rail and motor transport personnel will give technical assistance in planning loads and will recommend methods of securing cargo. Representatives of technical services may also be called on for assistance and advice about equipment distinctive to their specialty.

CHAPTER 14

MOTOR TRANSPORT

14-1. General

Trucks may be used to support troops in combat, clear congested areas, connect other modes of transportation, adjust the distribution of supplies within a depot, and support inland terminals. In terminal operations their primary role is delivery and clearance of cargo.

14-2. Weight and Load Distribution

a. Weight and cube are normally marked on cargo so it can be easily seen. If the weight is not marked, it can usually be determined from the ship's manifest or other shipping records. If cargo is not marked and loading data on the weights of different types of cargo are not available, the weight of the cargo must be estimated.

b. The distribution of weight on a motor vehicle affects the life of the frame, tires, axles, and other parts. A truck can be loaded within its rated gross weight capacity; yet individual tires and axles may be overloaded. Overloading may result from improper distribution of heavy cargo so that the load is excessive over a tire or an axle (fig 14-1). Loads, such as structural steel, iron pipe, and lumber, may project far beyond the rear axle, thereby overloading the rear axle and tires and tend to lift the front wheels, reduce front-wheel traction, and make steering difficult.

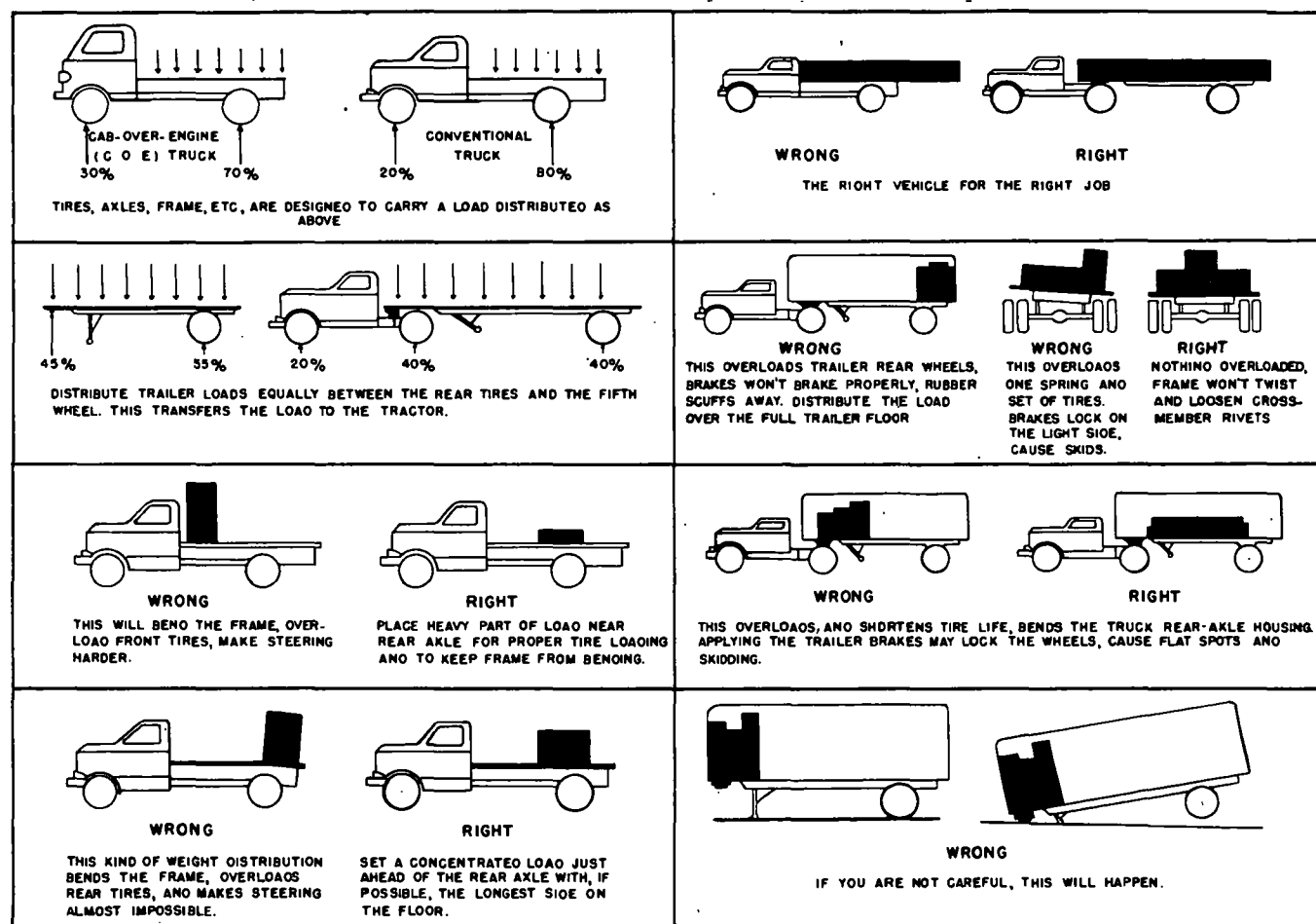


Figure 14-1. Right and wrong ways to distribute truck loads

14-3. Rules for Loading

The driver is not usually required to handle cargo during loading and unloading, but he is responsible for seeing that his vehicle is loaded properly and the cargo lashed properly.

a. The following rules should be observed for correct loading:

(1) A vehicle should not be loaded beyond the limit appearing on the vehicle data plate or the lower limit sometimes prescribed by the responsible commander.

(2) Heavy supplies should be placed at the bottom of the load and properly distributed.

(3) In building up the load, cargo should be placed carefully so that it will not shift and so that the weight is evenly distributed.

(4) Loosely distributed loads should not be built up too high. High, loose loads cause swaying, make the vehicle difficult to handle, and increase the danger of losing the cargo or overturning the vehicle.

(5) If the truck is not a covered vehicle, a tarpaulin should be placed over cargo as a protection against sun, dust, rain, or pilferage.

b. The safety of loads in cargo vehicles depends

upon the protection offered by the stakes or sides, the tailgate, and the tarpaulin with its rear and front curtains. Loads consisting of objects that are longer or higher than the body of an open cargo truck should be lashed.

14-4. Unitized Loads

a. *General.* Because unitized cargo is made up of loads of uniform size, it is possible to preplan loads for cargo trucks and trailers.

b. *2½-Ton, 6x6 Cargo Trucks.*

(1) Containers can be loaded into 2½-ton trucks by placing one container in each truck longitudinally. The weight of the container, the condition of the vehicle, and the condition of the road must be considered to prevent overloading vehicles.

(2) If M34 and M135 2½-ton, 6x6 trucks are to carry unitized loads, a frame must be built between the fender wells, using 2- by 4- by 4-inch lumber, to make a level floor across the body of the vehicle. When a frame is used, blocking and bracing are necessary. Frames may be built to facilitate loading and unloading using forklifts.

c. *Stake-and-Platform Semitrailers (fig. 14-2).*

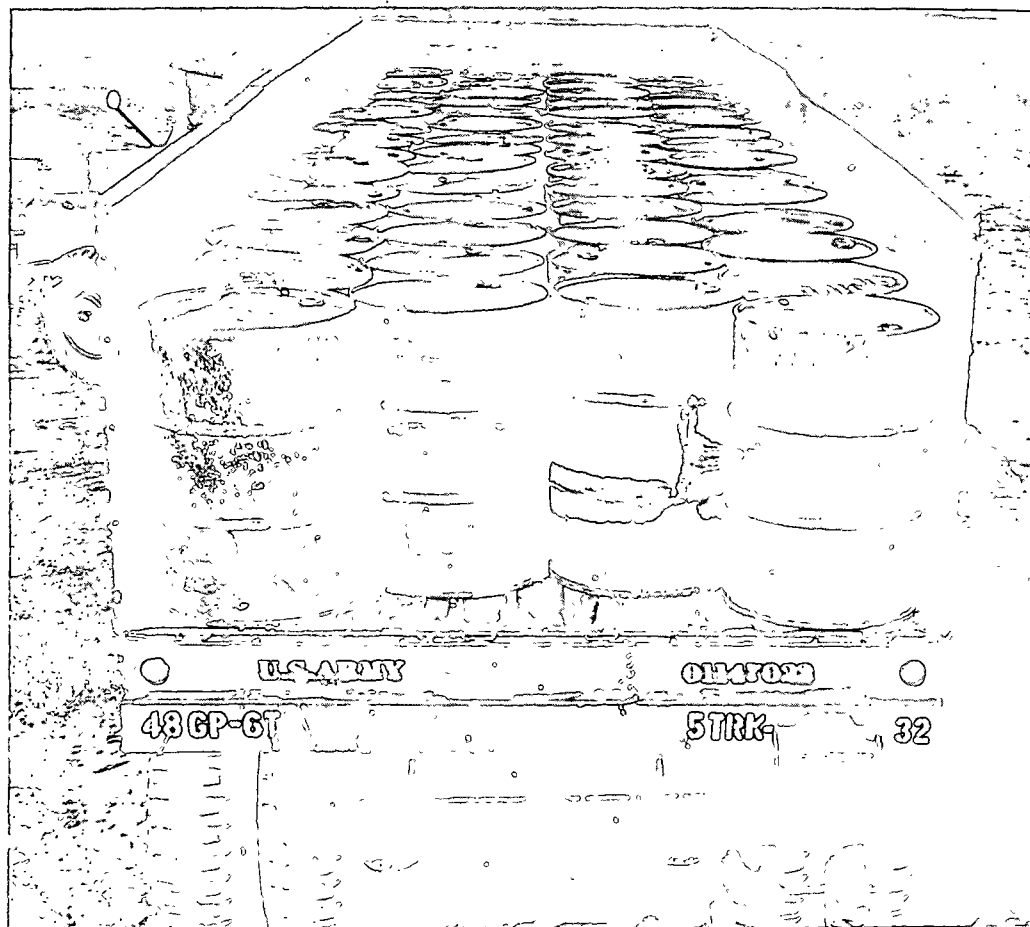


Figure 14-2. Typical semitrailer load.

(1) Palletized loads.

(a) The number of palletized loads that can be carried in stake-and-platform semitrailers depends on the weight of the pallets and the model of the trailer. The M127 12-ton semitrailer is well suited for this type of cargo. The weight of the cargo dictates the manner in which the pallets are placed on the bed of the trailer.

(b) Palletized loads may be loaded in semitrailers in the following ways:

1. A trailer is spotted directly beneath the cargo boom during discharge, and palletized loads are placed on the trailer directly from the cargo hook. The position of the trailer must be changed between drafts, and each pallet must be landed in its exact stowage position on the trailer. This may delay the discharge.

2. Palletized loads may be loaded on semitrailers by forklift trucks. During vessel discharge, semitrailers may be spotted a short distance from the side of the vessel in a position that will permit forklifts to approach them from either side. The draft is landed on the pier and moved to its position on the semitrailer by a forklift. This method permits the ship's cargo handling gear to operate at maximum speed and eliminates the delay caused by maneuvering the trailer and steadying the draft.

3. Truck-mounted or crawler cranes may be used to load pallets aboard semitrailers. A pallet bridle is attached to the cargo hook of the crane, and the pallets are loaded on the bed of the trailer.

(2) Containerized loads.

(a) Containers are placed in semitrailers so that the weight of the load is spread evenly over the bed of the trailer. During vessel discharge, containers are handled more slowly than palletized loads. Because of their size and weight, containers may be handled best by loading directly from the cargo hook to the trailer. The trailer can normally be maneuvered into position between loads without slowing discharge.

(b) Cranes may be used to load containers on semitrailers. Cranes are usually employed when a shortage of semitrailers makes it impossible to load containers directly from the cargo hook to the semitrailer. The containers are moved to an area adjacent to the pier by forklift trucks and loaded onto semitrailers by crane as the semitrailers become available.

d. *CONEX Tiedown Systems.* Proper tiedown systems for CONEXes on various motor vehicles are shown in figures 14-3 through 14-6. (Proper securing of containers similar to MILVAN's is discussed in chapter 9.)

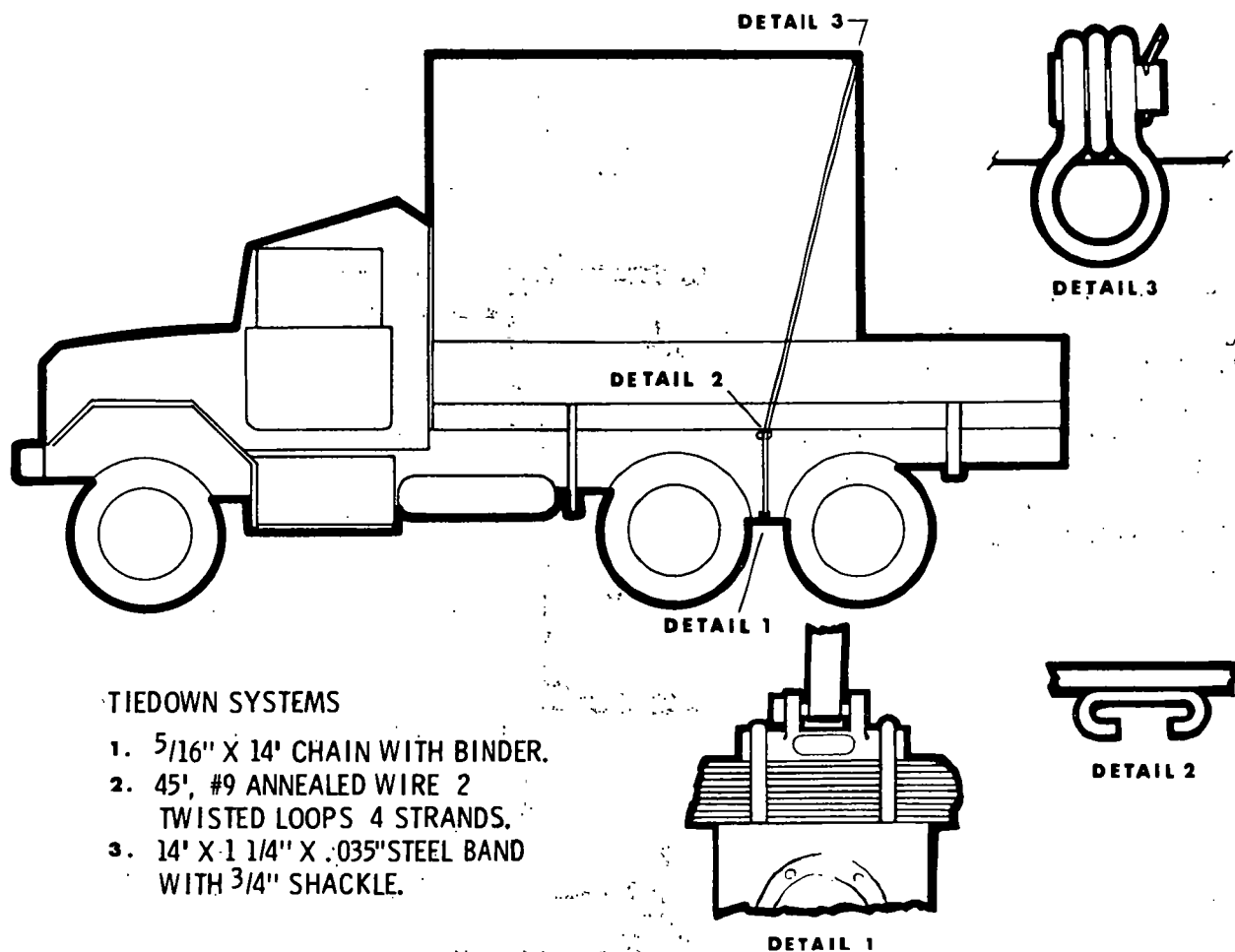


Figure 14-3. Recommended tiedown for CONEX on M35 truck.

TIEDOWN SYSTEMS

- A. 5/16" X 14' CHAIN WITH BINDER.
- B. 47', #9 ANNEALED WIRE 2 TWISTED LOOPS 4 STRANDS.
- C. 14' X 1 1/4" X .035" STEEL BANDS.
 - (1) 2" X 8" X 8' CLEAT, 24 EA. 12d COMMON NAIL TWO ROWS NAILED TO FLOOR OF TRAILER IN STAGGERED PATTERN.
 - (2) 2" X 6" X 8' CLEAT, 40d COMMON NAIL, 11 EA, NAILED TO BOTTOM CLEAT '1' IN OPPOSITE STAGGERED PATTERN OF PIECE '1'.
 - (3) 2" X 4" X 8' CLEAT, 12 EA. 12d COMMON NAIL NAILED TO SECOND CLEAT '2' IN STAGGERED PATTERN.

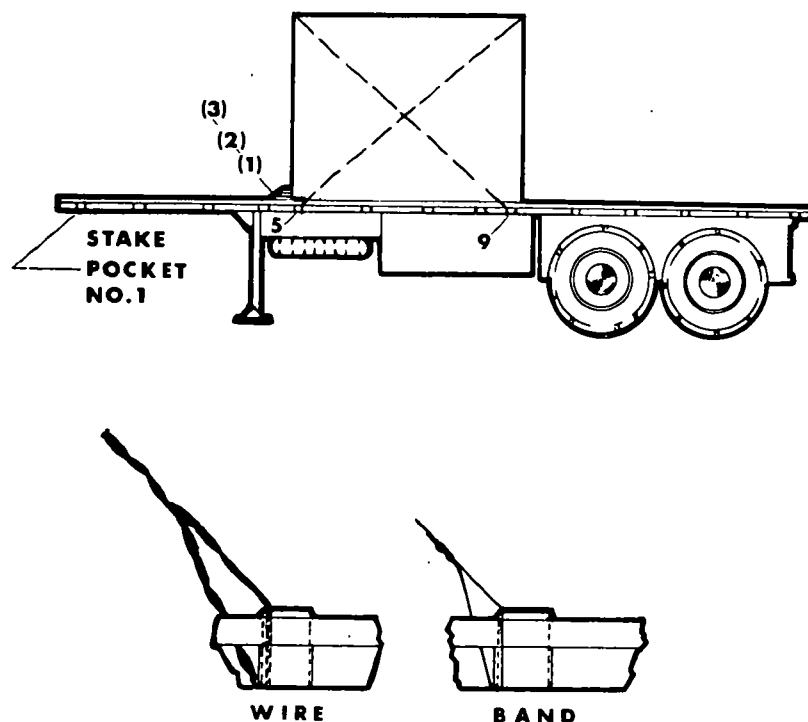
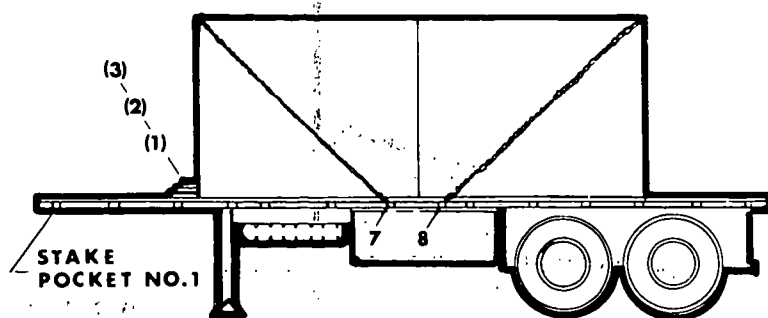


Figure 14-4. Recommended tiedown for one CONEX on M127 semitrailer.

TIEDOWN SYSTEMS

- A. 5/16" X 14' CHAIN WITH BINDER.
- B. 47' #9 ANNEALED WIRE 2 TWISTED LOOPS 4 STRANDS.
- C. 14' X 1 1/4" X .035" STEEL BANDS.
 - (1) 2" X 8" X 8' CLEAT, 24 EA. 12d COMMON NAIL IN TWO ROWS NAILED TO FLOOR OF TRAILER.
 - (2) 2" X 6" X 8' CLEAT, 11 EA. 40d COMMON NAIL NAILED TO BOTTOM CLEAT '1' IN STAGGERED PATTERN.
 - (3) 2" X 4" X 8' CLEAT, 12 EA. 12d COMMON NAIL NAILED TO SECOND CLEAT '2' IN STAGGERED PATTERN.



TIEDOWN FOR 'A' SYSTEM (CHAIN)

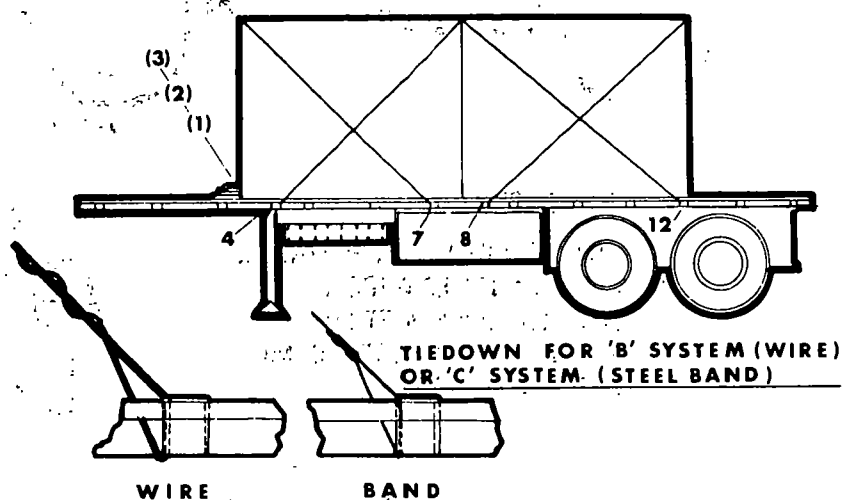
TIEDOWN FOR 'B' SYSTEM (WIRE)
OR 'C' SYSTEM (STEEL BAND)

Figure 14-5 Recommended tiedown for two CONEXes on M127 semitrailer

TIEDOWN SYSTEMS:

- A. 5/16" X 14' CHAIN WITH BINDER.
- B. 47' NO. 9 ANNEALED WIRE 2 TWISTED LOOPS 4 STRANDS.
- C. 13' X 1 1/4" X .035" STEEL BAND.
 (1) 2" X 8" X 8' CLEAT, 24 EA. 12d COMMON NAIL IN TWO ROWS NAILED TO FLOOR OF TRAILER.
 (2) 2" X 6" X 8' CLEAT, 11 EA. 40d COMMON NAIL NAILED TO BOTTOM CLEAT '1' IN STAGGERED PATTERN.
 (3) 2" X 4" X 8' CLEAT, 12 EA. 12d COMMON NAIL NAILED TO SECOND CLEAT '2' IN STAGGERED PATTERN.

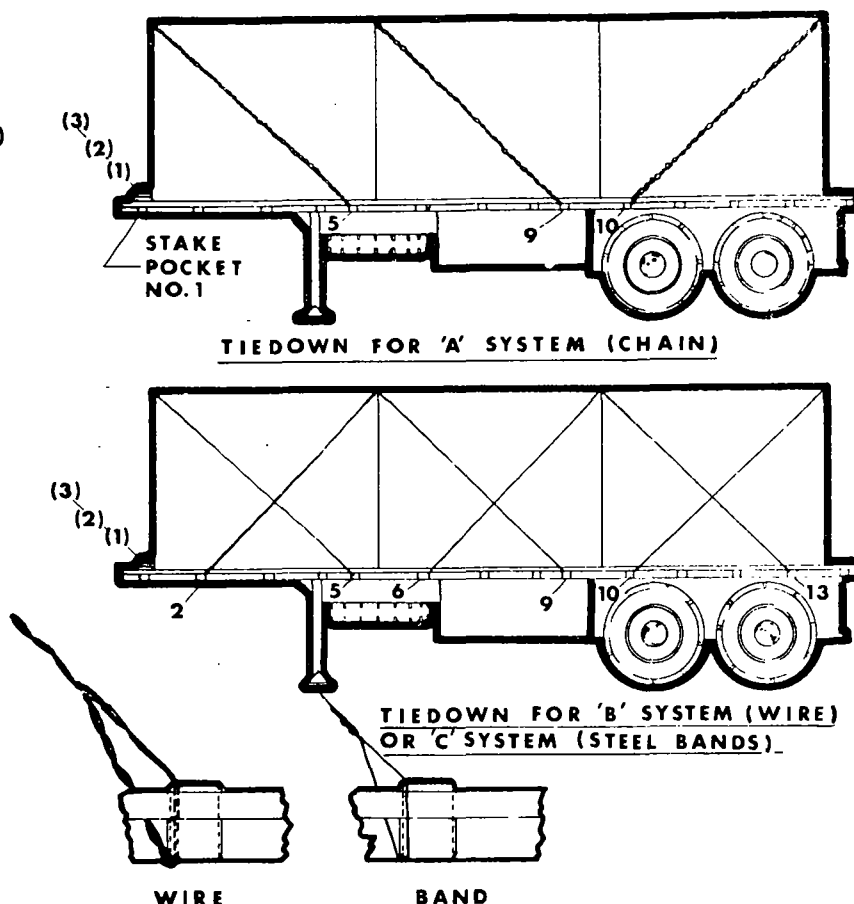


Figure 14-6. Recommended tiedown for three CONEXes on M127 semitrailer.

14-5. Explosives and Flammable Liquids

The following guidelines from the Department of Transportation pertain to the shipment of explosives and flammables by military forces in a theater of operations and are applicable in the United States. Methods of handling such cargo overseas depends on circumstances and the military urgency. Regulations for handling dangerous cargo are agreed upon jointly by representatives of the US Armed Forces and the authorities of the governments concerned. All personnel must be constantly reminded of the safety rules governing the handling and moving of dangerous cargo. Officers and non-commissioned officers responsible for the handling of dangerous cargo must thoroughly instruct their personnel in safety rules and enforce them through constant supervision and on-the-spot correction of any violation.

a. Jars or shocks must be avoided in handling explosives, particularly the sensitive explosives used in detonators. Containers packed with explosives should never be carelessly rolled, thrown, or dropped. All reasonable precautions (such as stopping the engine and placing the

vehicle in gear, setting the handbrake and blocking the wheels) should be taken to prevent accidental movement of vehicles while they are being loaded or unloaded.

b. Unless there is a need for secrecy, vehicles carrying explosives should be clearly identified.

c. The following safety rules must be observed by all personnel moving gasoline or explosives:

(1) Every possible effort must be made to prevent fire.

(a) Smoking must be forbidden within 50 feet of any truck or trailer loaded with explosives or flammable liquids.

(b) Open flames, such as matches, cigarette lighters, torches, etc., must be prohibited within 100 feet of any vehicle loaded with explosives or flammable liquids.

(c) Each truck hauling explosives and flammables must have two fire extinguishers, one inside the cab and one outside on the driver's side. In areas where considerable quantities of explosives and flammables are being handled, special apparatus must be available for fighting large-scale fires.

(d) All personnel must be instructed in the

use of fire extinguishers. When practical, instruction should be supplemented by demonstration.

(e) When a vehicle catches on fire, all vehicles should be moved away from the vicinity of the fire and all traffic stopped. Every effort must be made to warn personnel in the vicinity of the danger.

(f) When loading or unloading vehicles, explosives or flammables must not be placed near the exhaust.

(g) Ignition and lighting systems must be properly insulated and frequently inspected to eliminate danger from short circuits.

(h) Motor vehicles transporting explosives or flammables must not be driven past a fire until it has been ascertained that it can be passed with safety.

(i) Gasoline-powered forklifts or dock tractors being used where explosives or flammables are being handled should be equipped with spark arresters.

(2) Fuses and detonating devices must not be carried in the same vehicle with other explosives (fixed ammunition is an exception).

(3) The interior of the truck body should be

lined so that every portion of the lining with which a container may come into contact will be of wood or other nonsparking material.

(4) Loads must be blocked and lashed to prevent shifting.

(5) The motor must be stopped when explosives or flammables are being loaded or unloaded.

(6) A tarpaulin should be used with open-body vehicles to protect the cargo from rain and sun.

(7) The entire cargo of explosives or flammables should be contained within the body of the vehicle. The truck tailboard or tailgate must be closed and secured.

14-6. Additional Materials Handling Equipment

It is often necessary to move cargo being discharged from a vessel to a warehouse on or near the pier for temporary storage or for further segregation of cargo. When vehicles become available or the cargo is ready to be moved to destination, forklift trucks, pallet jacks, roller conveyors, rollers, warehouse trailers, and handtrucks may be used for loading the trucks or trailers.

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CHAPTER 15

RAIL

15-1. General

Railroad facilities serving terminals in a theater of operations may be at the head of a pier or at an inland transfer point. The transfer point may be truck to rail or amphibian to rail. Since personnel assigned to terminal service units may be used for the cargo handling operations necessary when loading or unloading rail equipment, they must know how to load, unload, and secure all types of military cargo on railcars.

15-2. Equipment

a. Types of railcars used for the movement of military cargoes are—

(1) Open-top cars—flatcars and gondolas.

(2) Closed cars—all boxcars, including refrigerated and heated cars for carrying perishable cargo.

(3) Tank cars—used to transport liquid in bulk.

b. It is often necessary because of the military situation to use open-top cars for cargo that under ordinary circumstances would be shipped in closed cars. Tarpaulins, dunnage, and other protective materials must be used to give maximum protection to such cargo.

c. Cars must be inspected to see that they are suitable to carry loads safely to destination.

15-3. Capabilities and Load Limits

Regulations of the Department of Transportation (DOT) and the Association of American Railroads (AAR) govern the procedure for loading freight equipment in the United States and set a definite load limit for each car. The load limit represents the maximum load under which a car can operate safely. This load, combined with the light weight of a car, gives the maximum AAR axle loading for the car. Loads must be placed so that there is no more weight on one side of the car than the other. The load on one truck wheel unit containing two or more pairs of wheels, brake components, center

casting, and truck bolster, located at each end of a car, must not exceed one-half the load limit stenciled on the car. (Complete details of railcar loading are contained in TM 55-601.)

15-4. Foreign Cars

a. Foreign locomotives are usually smaller than those in the United States and have less tractive effort; consequently, their capacities are less. Rolling stock is generally smaller and lighter. Since many foreign cars do not have automatic brakes, they must travel at greatly reduced speeds or use additional personnel in the train crews to operate the brakes by hand.

b. Generally speaking, foreign railroads do not handle the volume of traffic that is handled in this country. The average length of haul is much shorter and the equipment much lighter. Therefore, the length of the train and the gross tonnage are considerably less than that of the average freight train in the United States.

c. Caution should be taken when loading heavy equipment in foreign cars because the floors are not as strong as those of American cars.

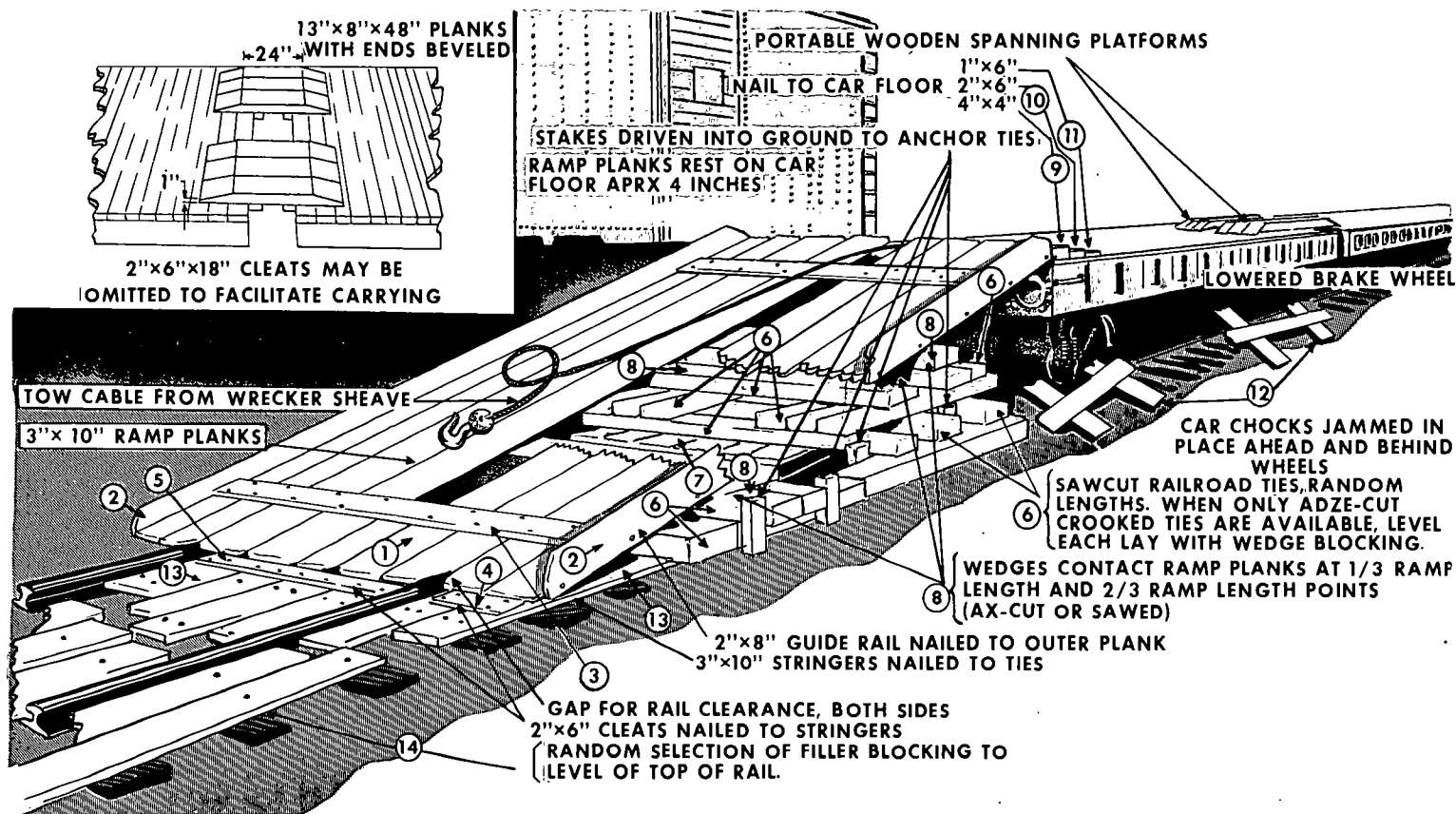
15-5. Loading Vehicles in Railcars

a. *Open-Top Cars.*

(1) *Flatcars.*

(a) Vehicles are loaded and unloaded with hoisting equipment when available. Mobile or crawler cranes are generally used. Heavy vehicles, such as tanks, tractors, etc., are hoisted by gantry cranes. Hoisting by cranes is a simple procedure, provided proper slings are used. Spreaders must be used to protect radiators, fenders, and the rear of the body from being crushed.

(b) When vehicles must be loaded from ground level, a ramp can be improvised using railroad ties and planking. A ramp suitable for loading most ordnance items is shown in figure 15-1.



BILL OF MATERIALS FOR RAMP AS ILLUSTRATED					
PART NO	QUANT REQD	PART NAME	LENGTH	WIDTH	THICKNESS
1	9	RAMP PLANKS	20 FT	10 IN	3 IN
2	2	GUIDE RAILS	20 FT	8 IN	2 IN
3	2	TIE STRIPS	8 FT	8 IN	1 IN
4	2	CLEATS	18 IN	6 IN	2 IN
5	1	CLEAT	56 IN	6 IN	2 IN
6	31	RAILROAD TIES	8 FT	8 IN	8 IN
7	AS REQD	FILLERS	AS REQD	10 IN	3 IN
8	AS REQD	WEDGES (CUT TO FIT)	8 FT		
9	1	STEPDOWN PIECE	8 FT	4 IN	4 IN
10	1	STEPDOWN PIECE	8 FT	6 IN	2 IN
11	1	STEPDOWN PIECE	8 FT	6 IN	1 IN
12	4	CHOCK BLOCKS	AS REQD	4 IN	4 IN
13	AS REQD	STRINGERS	AS REQD	10 IN	3 IN
14	AS REQD	GROUND DUNNAGE	AS REQD		

NOTES:

- RAMP SHOWN IS OF CAPACITY OF LARGEST END-LOADING FREIGHT CAR. FOR LESSER LOADS, REDUCE NUMBER OF RAMP PLANKS.
- WIDTH DETERMINED BY TREAD OF MATERIEL BEING LOADED.
- FOR LOADING TWO-WHEELED ARTILLERY TRAILERS, OR SHORT-WHEELBASE MATERIEL, RAMP PLANKS MAY BE SHORTER.
- CAUTION: WHEN RAMP IS TOO SHORT, UNDERPINNING OF MATERIEL WILL STRIKE END OF RAMP.
- OPENING AT CENTER MAY BE FILLED UP TO THE CAR COUPLER TO AVOID INJURY TO MANEUVERING PERSONNEL.
- FOR LOADS OVER 40 TONS, APPROACH END OF FLATCAR MUST BE BLOCKED UP TO AVOID TIPPING OF FLATCAR.
- THIS TYPE RAMP IS ADAPTABLE TO DRDP-END GONDOLA AND AUTO END-DDDR BOXCAR LOADING.
- WHEN LOADING AN AUTO END-DDDR BOXCAR, IT MAY BE NECESSARY TO LOAD A FLATCAR COUPLED TO THE BOXCAR TO GAIN OVERHEAD LOADING CLEARANCE.
- WHEN LOADING BY WRECKER CABLE, WITH PULL AT 90 DEGREES TO TRAIN, USING A SHEAVE, FLATCAR AT POINT OF PULL MUST BE LASHED TO ADJACENT RAILS, CARS, OR OTHER FIXED OBJECT.

Figure 15-1. Improvised end ramp for loading vehicles on a flatcar.

1. For loading small vehicles, the width of the ramp may be reduced to two double-plank runways, with the planks in each cleated together. The short wheelbase on some multiaxle items and the undercarriage or underhull clearance determines the length of the planking.

2. The freight car bearing the ramp must be securely blocked against rolling. Successive cars must remain coupled and be chocked at several points along the train when vehicles are being towed aboard the train.

3. If the freight cars are not on an isolated track or blocked siding, each end approach to the train must be placarded (blue flag or light) to indicate that men are at work and that the siding cannot be entered beyond the placarded points.

4. Vehicles that can be loaded under their own power are driven onto the improvised apron at the base of the ramp and guided into position on the flatcar.

5. Vehicles that have been processed must be towed onto the improvised apron at the

base of the ramp and unhitched. A cable attached to the vehicle and laid along the centerline of the flatcar is used to pivot the vehicle so that it points toward the ramp. Personnel who assist in pivoting the vehicle into position must be careful to avoid injury from sidwhipping action likely to occur when strain is applied to the cable. After the first vehicle has been loaded on the flatcar, additional vehicles may be similarly hauled aboard by passing the towing cable beneath the loaded vehicle. For powering the towing cable, a vehicle with winch is spotted at a right angle to the train (fig 15-2). The vehicle is spotted at about the third or fourth flatcar to facilitate signaling and because of cable-length limits. A single-sheave snatch block located between cars on the train centerline provides the necessary lateral pull. Vehicles passing the snatch block can be towed by a vehicle on the ground. A long tow cable from the towing vehicle lessens the tendency of the towed vehicle to stray from the centerline of the train.

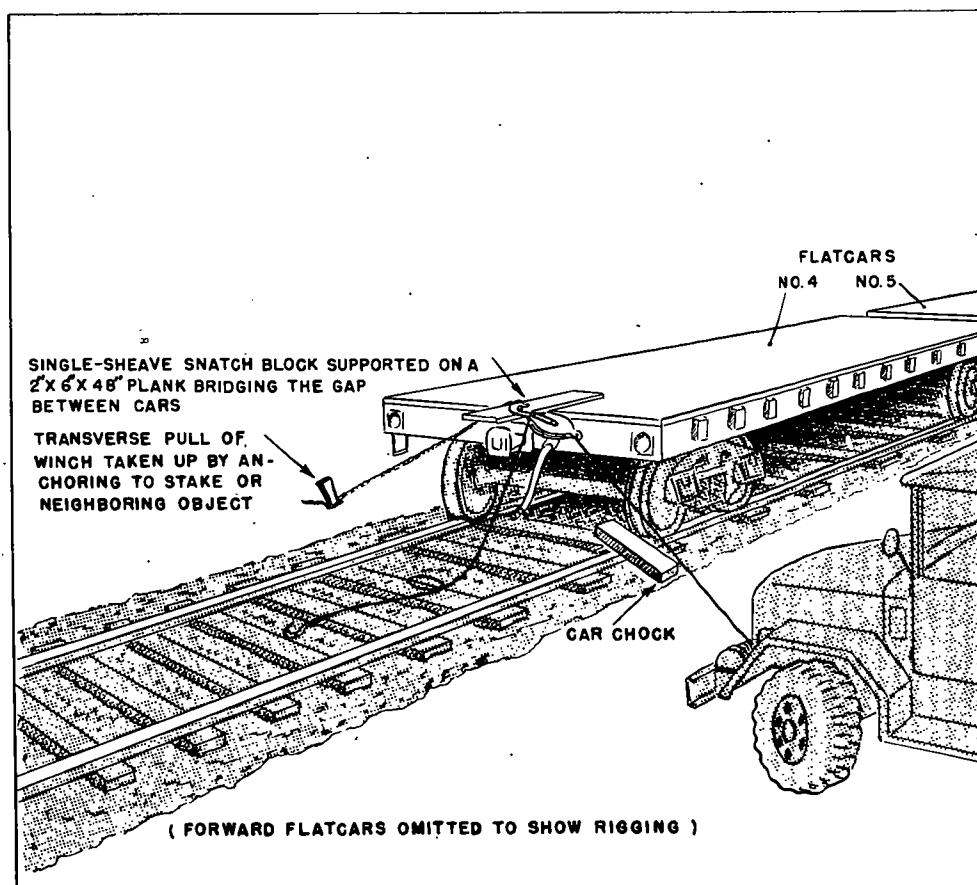


Figure 15-2. Vehicle with winch used to power towing cable.

6. When a train of flatcars is being loaded, steel or wooden spanning platforms

(spanners) or bridges are used to cover the gap between cars. Flatcar brake wheels must first be

lowered to floor level to permit passage. A pair of improvised spanning platforms is shown in the inset in figure 15-1. Spanning platforms are moved along the train by hand as the vehicle advances.

7. Upon completion of loading, the ramp planks and bridging devices should be loaded on the train for use in unloading. Random sizes of timbers, used in building the approach apron up to rail level, should be included. After vehicles have been blocked, all material should be securely fastened to the car floors and entered in the bill of lading.

(2) *Gondola cars.*

(a) Vehicles can be loaded in fixed-end gondola cars only when hoisting facilities are available for initial loading and for unloading at destination. False flooring must be added to hopper or drop-bottom gondola cars in which unboxed vehicles are shipped.

(b) Drop-end gondola cars can be loaded exactly as described for flatcars (1) above). When gondola cars are ordered, the inside width required must be specified since some gondolas have gussets along the inner sides that affect clearance; height of fixed sides is immaterial. Vehicles may progress through gondola cars by passing over two inwardly-dropped ends or over spanning platforms.

b. *Boxcars.*

(1) End-door boxcars are spotted with the door end toward the ramp and loaded as described for flatcars (a(1) above), except that the vehicle must be pushed into the boxcar or towed by cable and block. A vehicle that is almost as high as the inside height of the boxcar may first be loaded on an adjacent flatcar. The flatcar is coupled to the door end of the boxcar after the two end doors have been opened. When end-door boxcars are ordered, inside height must be specified since

some automobile boxcars have an overhead built-in automobile-loader rack that affects inside height calculations. Open-end doors must be kept clear of traffic on adjacent tracks.

(2) Vehicles can be loaded in ordinary boxcars by using roller automobile jacks to maneuver them into place. Automobile boxcars have large single or double sliding doors at each side. They must be loaded from a platform of about the same level as the boxcar floor or from an adjacent flatcar. Steel plates or spanning platforms must be used to bridge the gap between platform and car.

c. *Blocking and Bracing Vehicles for Regular Freight Train Service.*

(1) *Blocking pieces.*

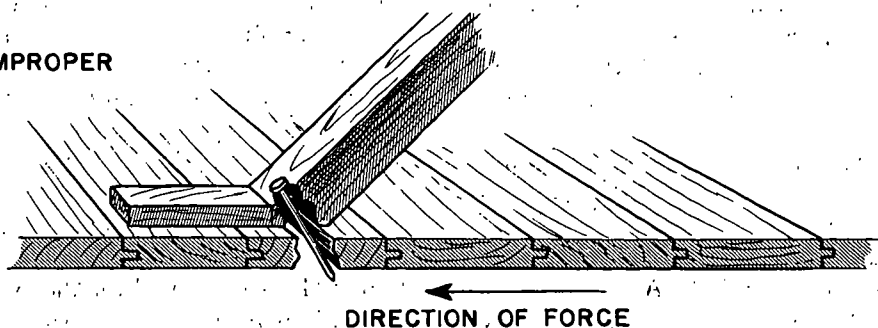
(a) *Quality.* All wooden bearing pieces, clamping pieces, braces, cleats, wedges, blocks, etc., must be made from straight-grained hardwood. They must be free from decay and strength-impairing knots. Metal blocking or suitable metal sections of equal strength may be substituted, except where metal substitutes are definitely prohibited.

(b) *Rods.* When rods are passed through the car floor or the stake-pocket to secure the load, a 4- by 4- by 18-inch hardwood cleat (sleeper) or a ½- by 4- by 18-inch steel plate is placed under the car floor or the stake-pocket and secured with nuts. To retain nuts in original position the threads on rods or bolts must be nicked immediately behind single or double nuts. When only one or two threads extend beyond nuts, the ends of the rods must be riveted over.

(c) *Sloping wedges.* When sloping wedges are used for end blocking against a vertical surface, the flat side of the wedge is placed on the car floor.

(d) *Nails.* All nails or spikes in blocking are driven vertically, as shown in figure 15-3.

IMPROPER



PROPER

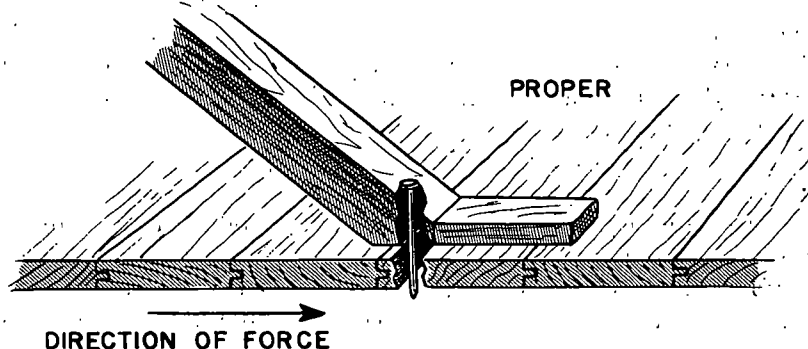


Figure 15-3. Right and wrong ways of nailing diagonal brace to car floor.

(2) *Blocking instructions.* Blocking instructions for vehicles are specified in TM 55-601. Add additional blocking as required at the discretion of the officer in charge.

15-6. Loading Unitized Cargo in Railcars

a. Palletized. In the United States, loading, blocking, and bracing of palletized shipments in railroad cars must conform to the instructions given in TM 55-601 and to pamphlets issued by the Association of American Railroads, Operating-Transportation Division, Freight Loading and Container Section. These rules may also be used as guides for a theater of operations. The following additional rules must be observed for palletized shipments:

(1) Block the load, not the pallet. A load smaller than the pallet must be increased so that it is even with or slightly larger than the outside edge of the pallet.

(2) Use bulkheads in the ends of the car when pallets are heavy and when dented car ends cause uneven surfaces.

(3) Use end gates as high as the entire height of the load. Loads that extend above gates put unnecessary strain on strapping.

(4) Be sure that pallets in car doorways (foreign or American) are accessible to forklift trucks (fig 15-4).

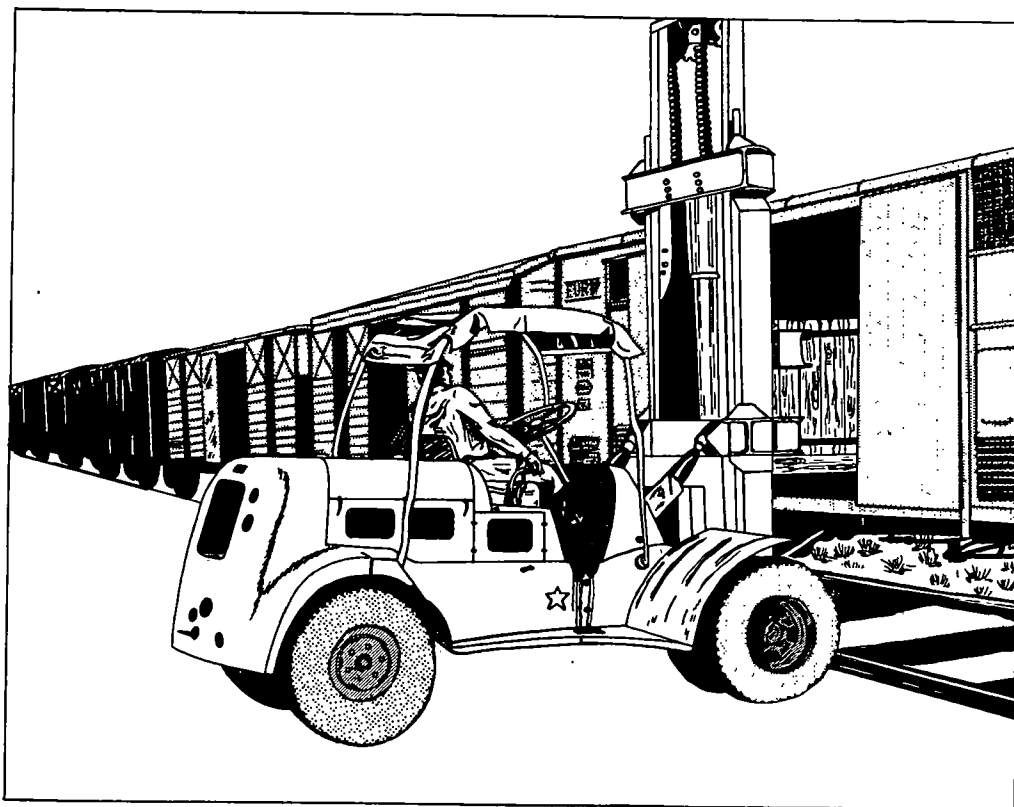


Figure 15-4. Loading foreign boxcar using forklift.

b. *CONEXes*. CONEX unit loads are lifted from the top and transferred from the truck, semitrailer, or amphibian to the railcar (fig 15-5). The pendants of the container bridle are fastened into lifting eyes at the four top corners. Since the lifting eyes are inside the external dimensions, containers may be contact-stowed on the railcar

with no space between them or between the side of the car and the containers. Rough terrain forklifts may be used for transferring containers from a truck or a semitrailer to a flatcar. The cargo bed of a truck with protruding fender wells should be built up with dunnage to facilitate insertion of the forks under the container.

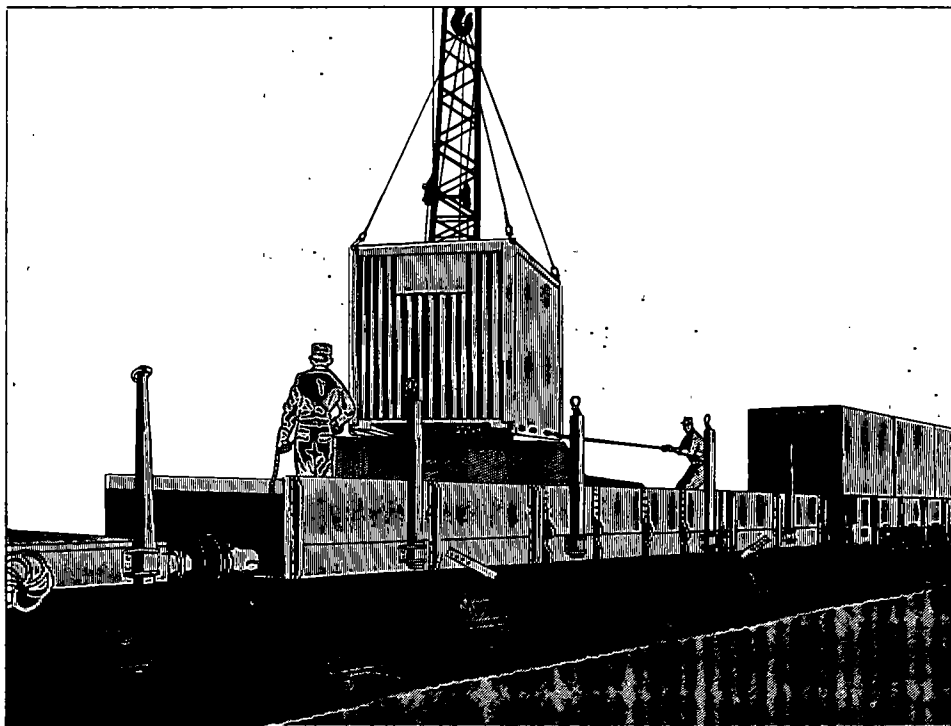


Figure 15-5 Loading CONEX on foreign flatcar.

c. *MILVAN's*. Figure 9-17 illustrates the proper loading of van containers similar to *MILVAN's*.

15-7. Skid Units

a. When a large machine part is shipped, such as a base casting, that does not have highly finished surfaces exposed and is so constructed as not to be damaged easily by shocks or exposure to weather, complete crating is usually unnecessary. Time and lumber can be saved by constructing skid units instead of complete crates or boxes.

b. If a part of an item on a skid unit needs protection, a box or a nailed wood housing can be applied over that part. On some items it may be desirable to use shrouds. In constructing skid units, special care must be used with fastenings since there are relatively few places to attach fastenings and these must resist the strains imposed by handling and shipment. Select lumber or timbers should be used so that large knots or other weak sections do not occur at or near a fastening point in the center of an unsupported span.

c. Skid unit loads are lifted from the bottom and transferred from the truck, semitrailer, or amphibian to the railcar. The lifting bars of the bridle are inserted on the outside of the skids and, when the units are loaded, sufficient space is left to remove the lifting bars.

15-8. Dangerous Cargo

Shipments of explosives and ammunition made by military establishments in the continental United States must comply with regulations of the DOT Hazardous Materials Regulations Board, port and harbor regulations, state and municipal laws, and recommendations of the Bureau of Explosives. Difficulties in complying with such regulations must be reported in detail through proper channels to the Commanding General, MTMC. DOT and AAR regulations applicable in the United States are good guides for shipment of explosives and flammables by military forces in the theater of operations as described in TM 55-602. (Paragraph 14-5 contains further information regarding the handling of dangerous and hazardous cargo in a theater of operations.)

15-9. Rules for Loading Carload Shipments of Ordnance Material in Closed Cars

a. *Inspection*. All freight cars must be inspected before they are loaded to see that they are in a suitable condition to safely carry loads to destination.

b. *Side Bearing Clearance for Loaded Cars*. Clearance between the side bearings and the undercarriage of the car must be sufficient for free curvature of trucks.

c. Maximum Load Weight.

(1) The weight of the load on a car must not exceed the load limit (not capacity) stenciled on the car.

(2) The weight of the load on one truck must not exceed one-half the load limit stenciled on the car. In case of doubt, the load must be weighed. Materiel loaded between truck centers and end of cars must not exceed 30 percent of the stenciled load limit (15 percent each end when both ends are loaded and 10 percent when loaded at one end only).

(3) Percentages of stenciled load limits as shown below must not be exceeded for a load located between a truck's center measured lengthwise of the car unless otherwise designated by the car owner by a footnote in the Association of American Railroads' Official Equipment Register.

<i>Load position</i>	<i>Percent</i>
10 feet or less from truck center	66.6
10 to 24 feet from truck center	75.0
24 feet from truck center	90.0
Truck center and over	100.0

The above percentages are for cars not equipped with a fish-belly center and side sills built prior to 1 January 1965. The following applies for cars with a fish-belly center and side sills, as well as other flatcars built after 1 January 1965.

<i>Load position</i>	<i>Percent</i>
Less than 18 feet from truck center	75.0
18 feet and over from truck center	100.0

d. Loading, Blocking, and Bracing.

(1) The load must be secured crosswise and lengthwise so that it will not contact side doors, roll, or shift in transit.

(2) All lumber used for blocking and bracing must be sound and free of defects that impair its strength or interfere with proper nailing.

(3) Machines and other items having a high center of gravity or a narrow base must be secured to prevent them from tipping over in transit.

(4) When lift trucks are used for loading and unloading, steel plates are placed in the car to prevent damage to the floor.

(5) High-tension bands or wires securing the load must be machine tensioned, sealed, or twist-tied. In addition, all banding used must be stamped "AAR Approved."

(6) If high-tension bands or high-tension wires are specified, either may be used if of equal load strength, provided all the other items used to secure the load are equal in number and strength. Table 15-1 lists the dimensions and load strengths of high-tension bands, high-tension wire, common annealed wire, rods, and bolts that are used for bracing and blocking items in freight cars.

Table 15-1. Dimensions and Load Strength of Bands, Wires, Rods, and Bolts

High-tension bands		High-tension wire			Common annealed wire			Rods and bolts	
Width and thickness (inches)	Load strength (pounds)	Gage No.	Diameter (inches)	Load strength (pounds)	Gage No.	Diameter (inches)	Load strength (pounds)	Diameter (inches)	Load strength at root of thread (pounds)
3/8 by 0.050	2,100	8	3/16	2,000	7	3/16	1,100	1/2	5,200
3/4 by 0.028	2,280	—	—	—	8	11/64	950	5/8	8,100
3/4 by 0.035	2,850	—	—	—	9	5/32	800	3/4	11,700
3/4 by 0.050	4,050	—	—	—	11	1/8	500	7/8	16,200
1 1/2 by 0.035	4,750	—	—	—	—	—	—	1	21,100
1 1/4 by 0.050	6,750	—	—	—	—	—	—	1 1/8	25,800
2 by 0.050	10,600	—	—	—	—	—	—	1 1/4	32,800
								1 3/8	38,600
								1 1/2	46,900

e. *Doorway Protection.* Doorway protection is provided when there is a possibility of cargo falling or rolling out of the doorway or coming in contact with side doors. Door openings are

protected with wood or metal ties of sufficient strength and number and adequately secured. Figure 15-6 shows an example of the construction of bulkheads for doorway protection.

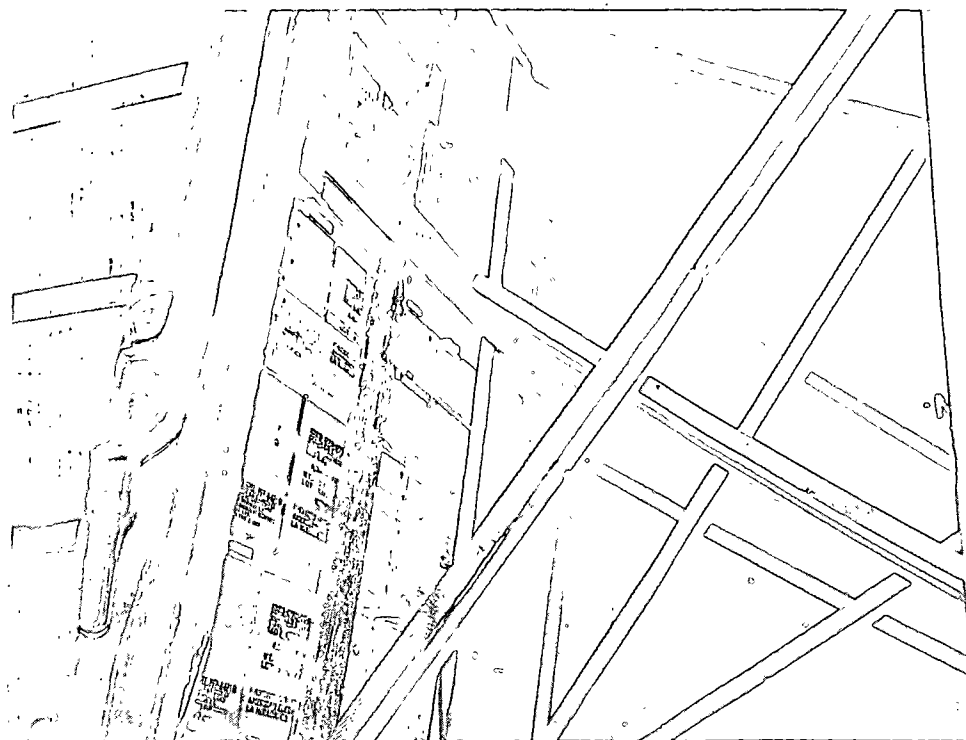


Figure 15-6. Correctly constructed bulkheads for doorway protection.

15-10. Idler Cars

a. Two or three cars may be used to carry a double or triple load in such a way that the extra car or cars carry no load but merely accommodate the overhang of a load too long for a single car. The cars on which cargo does not rest are known as idler cars. For example, a bridge girder 100 feet long may be loaded on a 50-foot gondola and have 25 feet of each end overhanging a flatcar or a gondola on each end of the shipment. The cars on each end of this triple load are idler cars. The waybill for the shipment carries the numbers of all three cars and designates the ones that are idlers. A crane on its own wheels with its boom lowered always has an idler to accommodate the boom. If the load of a two-car shipment rests on both cars, the second car is not considered an idler. In this case, each car is a part of the double or dual load.

b. If an idler is used on a two- or three-car

shipment is made, the uncoupling levers are always disconnected to prevent accidental separation of the cars. When cargo rests on two or more cars, steel shims are placed between the couplers and the buffer plates of each car. This eliminates slack between the cars.

c. Distribution of weight crosswise of a car must take into account the factors below:

(1) The load must be located so that the weight along both sides of the car is about equal for the entire length of the load.

(2) Suitable ballast is used to equalize the weight when the load cannot be placed to obtain equal distribution of weight crosswise of the car.

(3) Unless otherwise specified, if the vacant space between load and car sides exceeds 18 inches, the load must be secured to prevent its moving or slipping toward the sides of the car.

APPENDIX A

REFERENCES

A-1. Army Regulations (AR)

55-30	Space Requirements and Performance Reports for Transportation Movements.
55-55	Transportation of Radioactive and Fissile Materials.
55-167	Policy Governing Transportation of Cargo by Military Sea Transportation Service.
55-228	Transportation by Water of Explosives and Hazardous Cargo.
55-355	Military Traffic Management Regulation
56-15	Ship and Terminal Demurrage and Unused Shipping Space.
59-106	Operation of Air Force Terminals.
700-15	Preservation-Packaging, Packing, and Marking of Items of Supply.
700-58	Packaging Improvement Report.
725-50	Requisitioning, Receipt, and Issue System.
742-9	Ammunition Advisors and Specialists.
746-1	Color, Marking, and Preparation of Equipment for Shipment.

A-2. Field Manuals (FM)

9-6	Ammunition Service in the Theater of Operations.
19-30	Physical Security.
21-5	Military Training Management.
21-6	Techniques of Military Instruction.
21-30	Military Symbols.
55-16	Cargo Checking Handbook.
55-30	Army Motor Transport Operations.
55-50	Army Water Transport Operations (to be published).
55-58	Transportation Boat Operations.
55-60	Army Terminal Operations.
55-70	Army Transportation Container Operations.
101-5	Staff Officer's Field Manual: Staff Organization and Procedure.

A-3. Technical Manuals (TM)

5-725	Rigging.
9-1300-206	Ammunition and Explosives Standards.
10-252	Loading Insert Containers and Cargo Transporters.
38-230-1	Preservation, Packaging, and Packing of Military Supplies, and Equipment (Volume I).
38-230-2	Preservation, Packaging, and Packing of Military Supplies, and Equipment (Volume II).
55-310	Motor Transport Operations.
55-511	Operation of Floating Cranes.
55-601	Railcar Loading Procedures.
55-602	Movement of Special Freight.
55-606	Military Ocean Terminals, CONUS.

A-4. Department of the Army Pamphlets (DA Pam)

310-2	Index of Blank Forms.
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A-5. Tables of Organization and Equipment (TOE)

55-116	Headquarters and Headquarters Company, Transportation Terminal Battalion.
55-117	Transportation Terminal Service company.
55-118	Transportation Terminal Transfer Company

A-6. Department of Defense (DOD) Publications

DOD Reg 4500.32-R	Military Standard Transportation and Movement Procedures.
MIL-STD-129	Marking for Shipment and Storage.
MIL-STD-147	Palletized and Containerized Unit Loads 40" by 48" Pallets, Skids, Runner, on Pallet-Type Base

A-7. US Coast Guard (CG) Publications

108	Rules and Regulations for Military Explosives and Hazardous Munitions.
174	Manual for the Safe Handling of Inflammable and Combustible Liquids.
176	Loadline Regulations.
203	Merchant Marine Safety Manual.
257	Rules and Regulations for Cargo and Miscellaneous Vessels.

A-8. Military Sealift Command (MSC) Publication

MSC P504	Ship Register.
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Coast Guard publications may be requisitioned from Commandant, US Coast Guard, 400 Seventh St., SW, Washington, DC 20590.

Military Sealift Command publication may be requisitioned from Military Sealift Command, Department of the Navy, Washington, D C, 20390.

APPENDIX B

FIBER AND WIRE ROPE RIGGING

B-1. Scope

This appendix covers the elements of fiber and wire rope rigging usually important to the military cargo handler. (Elements of this subject area used less frequently may be found in TM 5-725.)

B-2. The Liverpool Splice

This splice is required by American maritime authorities and used by military cargo handlers for making slings, pendants, preventers, and cargo runners. It is made as described below.

a. When setting up to make the Liverpool splice, allow a portion of wire 36 times its diameter for the working end. On a vertical vise

such as shown in figure B-1(1), secure the eye with the standing end facing upward. This may be done with or without the metal thimble device shown at the neck of the eye, but use of the thimble is much preferable as it protects the rope from sharp bends and abrasive action. Unlay (untwist and separate) the working end down to the top of the vise. Tape the end of the strands, making sure they are covered. Number one strand lays up near the center of the standing part of the wire. Number the strands, one through six in a clockwise direction. Lay the core between strands number three and number four.



Figure B-1(1). Liverpool splice: securing the eye.

b. Figure B-1(2) shows where the marlinspike goes in for number one strand. (Note that it is three strands up from where number one is laying next to the wire.) At this point, it is useful to mention a formula describing the number of strands under which strands one through six are

inserted when tucked into the wire rope in numerical order. This formula is 3-2-1-1-1-1. Thus, the number one strand is tucked under three strands of the standing part of the wire, with the core of the wire still on its right.

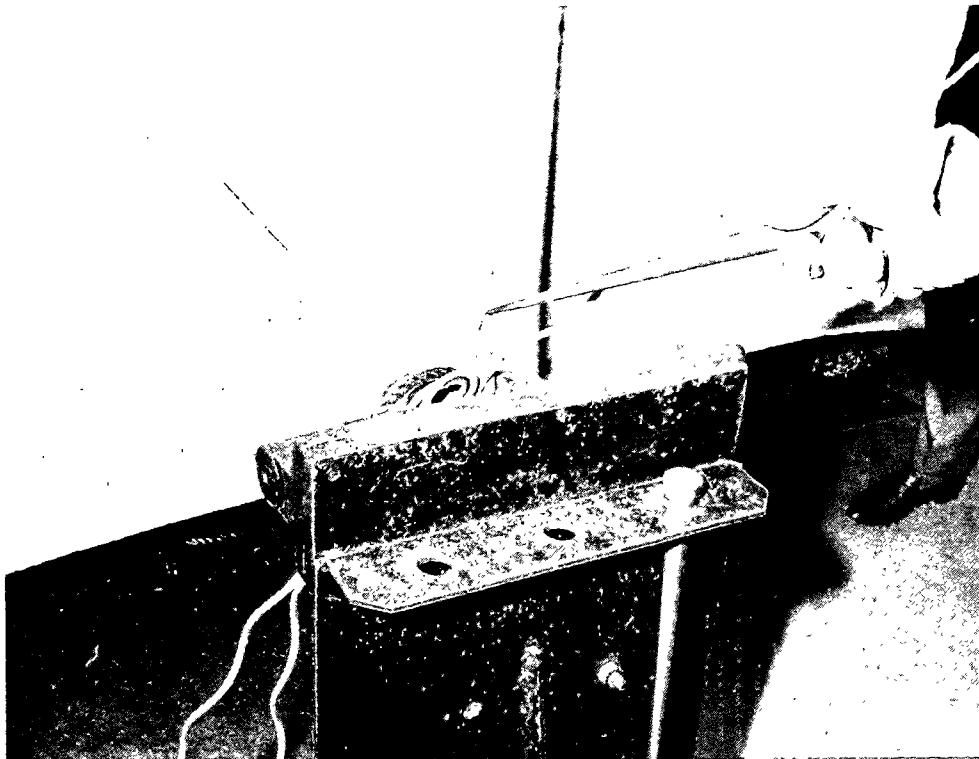


Figure B-1(2). Liverpool splice: insertion point for number one strand.

c. Figure B-1(3) shows the number one strand tucked, with its tip, under three strands of wire. The marlinspike is no longer where it was originally inserted. This is because before tucking, it is "run up" the wire (turned) approximately three-quarters of a full turn (as the thickness and bulk of the wire is increased, so will the amount of turn) to prevent kinking. The tucked strand has been tucked under the

marlinspike and there are no twists or kinks in the part of the strand leading up to the point of tucking because the strand has been wrapped to the right, around the wire, and inserted in the most favorable position created for it by the runup marlinspike. When being inserted, it is run up or run down for all strands but the core. The spike point should always be facing downward.

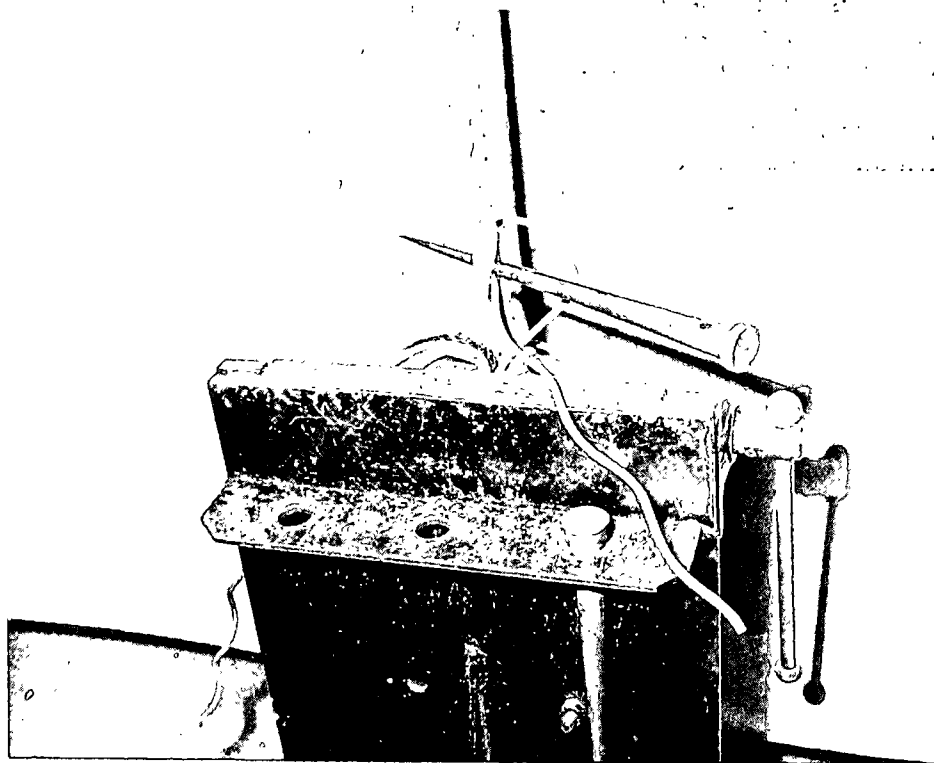


Figure B-1(3). Liverpool splice: number one strand tucked.

d. After the number one strand has been tucked and pulled all the way through the standing part of the wire, work it back down to the vise with the spike. Then, hold it down while running the spike back up the wire rope a full turn, thus locking number one strand in place.

e. Next, pull the spike out of the wire and reinsert it under two strands of the standing part of the wire (following the 3-2-1-1-1 formula) at a point one strand up on the standing part of the

wire from the rundown number one strand. The spike is facing in the same direction it was for number one at this point. Then run the spike up the wire three-quarters of a turn, insert the tip of number two strand and run it through under the spike after wrapping it around the standing part of the wire (fig B-1(4)). Then work it down with the spike and hold it down while running the spike back up and removing it.

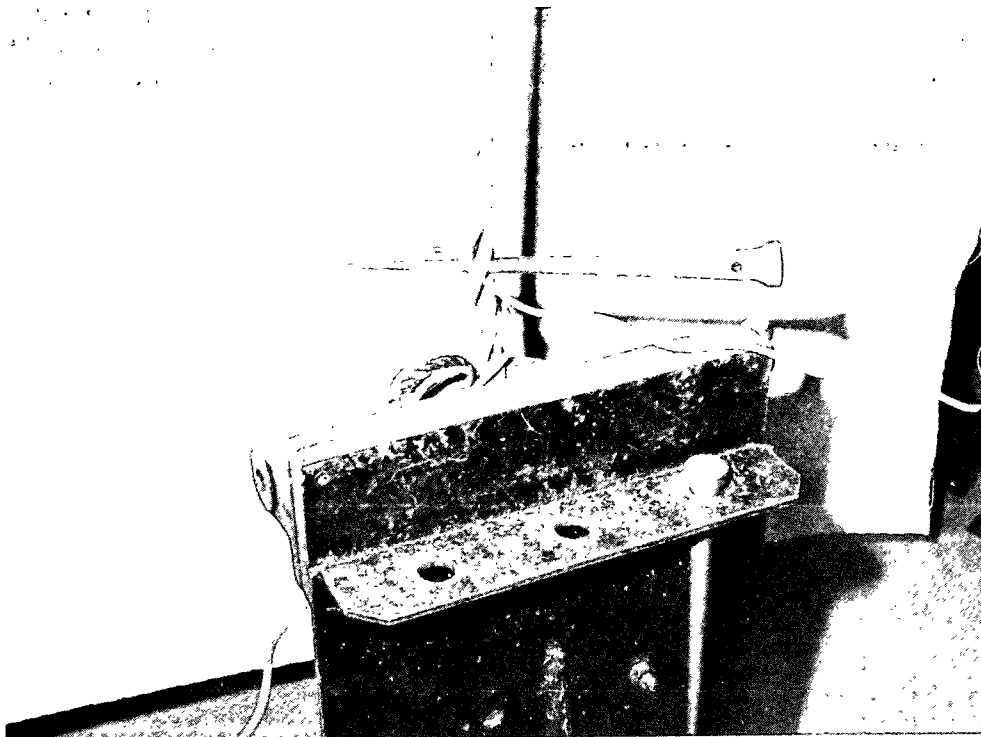


Figure B-1(4). Liverpool splice: number two strand tucked.

f. Insert the spike at a point one strand above pulled-down number two strand, pointing it in the same direction as strands one and two, but this time tuck it under only one strand of the standing

part of the wire, as per the formula. Then run the spike up the wire as before and wrap number three strand, tuck it (fig B-1(5)), work it down, and lock it in place as those before it.

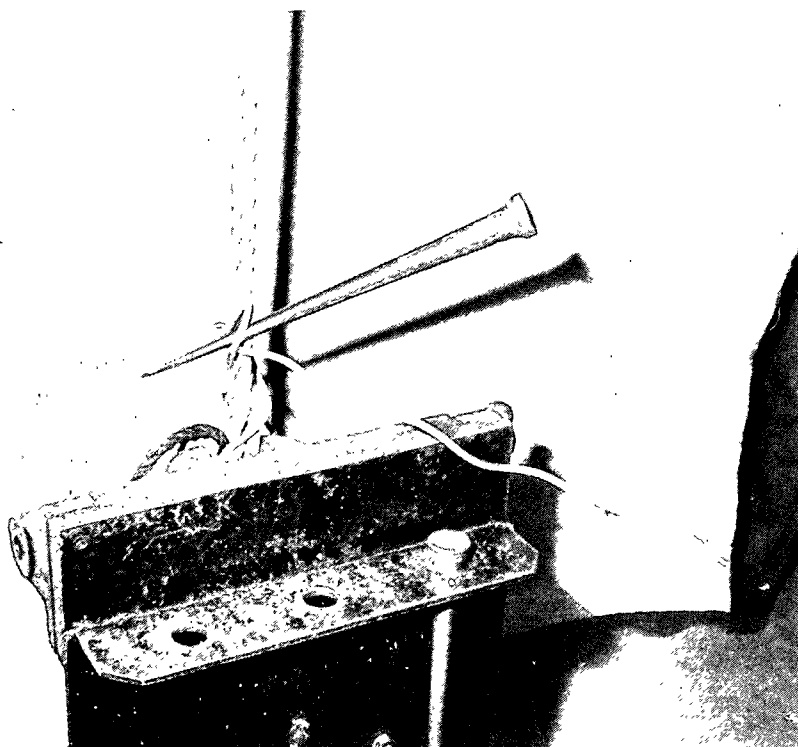


Figure B-1(5). Liverpool splice: number three strand tucked.

g. At this point, dip the core. Do this by running the spike through the standing part of the wire over the top of strands one, two, and three, and under the spike, with the point of the spike facing downward as it was for strands one, two, and three. Then push the spike downward at

the heel as far as it will go (about 90°) so that the tip of the spike is facing upward for the first time and give it one-fourth of a turn. Then run the core under the spike and down through the standing part (fig B-1(6)).

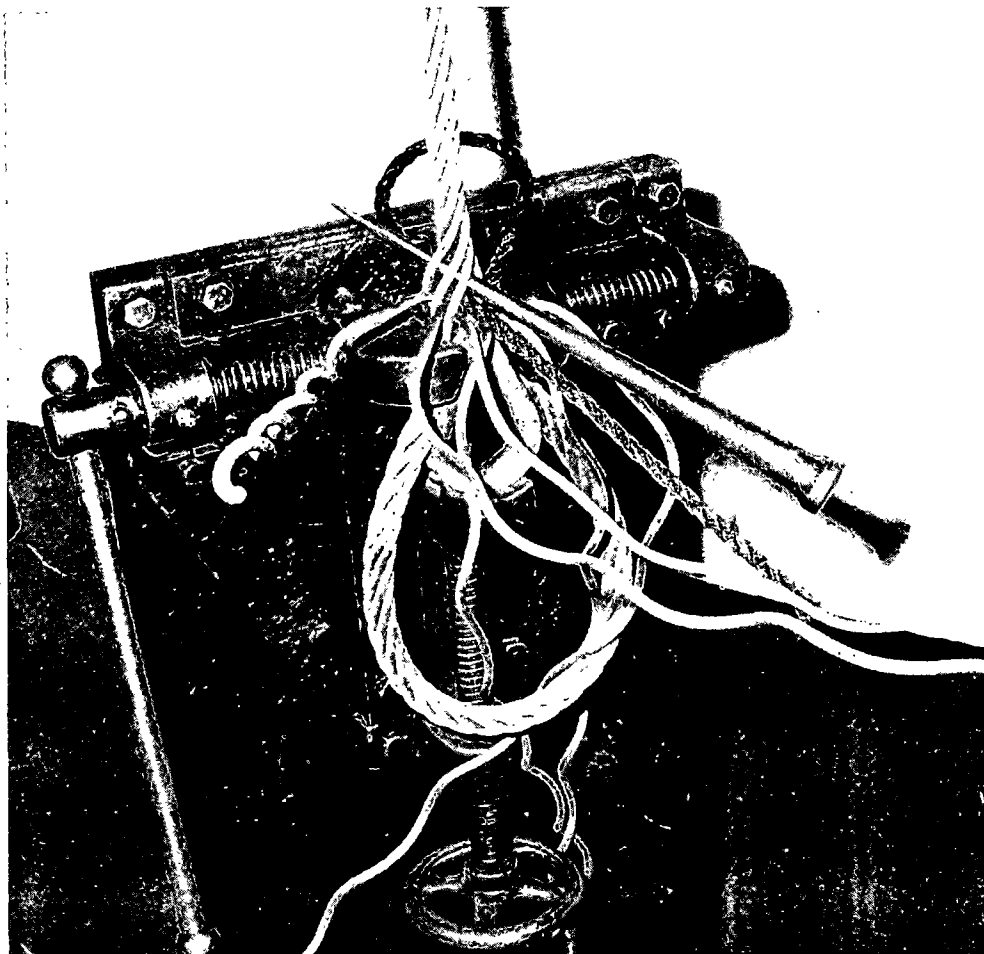


Figure B-1(6). Liverpool splice: dipping the core.

h. In order to tuck number four strand, the strand to the left of where strands one, two, and three were tucked (four strands up on the standing part from pulled-down strand number three) must be "picked up" by the spike; that is, insert the spike in the usual direction and just to the right of this strand so that the rest of the standing part is to the right of the spike. Then run the spike up three-fourths of a turn, tuck number four strand below the spike (fig B-1(7)), and run the spike down to its starting point. Then hold down

number four strand and lock it in place by running the spike up until the heel of the spike is directly over number four strand, with the spike's tip in place for the next tuck below it. The first tuck of number four strand is now complete. Without removing the spike, make tucks two, three, and four in a similar manner. After all four tucks are completed, remove the spike and bend strand number four up and out of the way (fig B-1(8)).

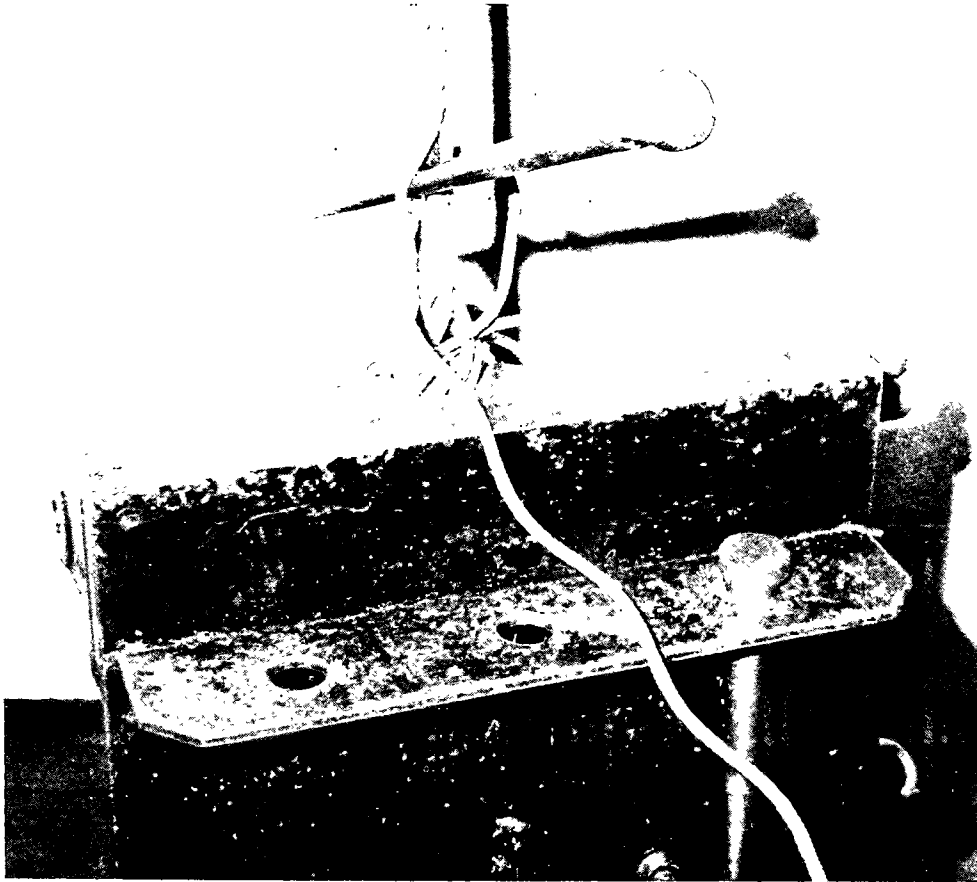


Figure B-1(7). Liverpool splice: initial tuck of number four strand.

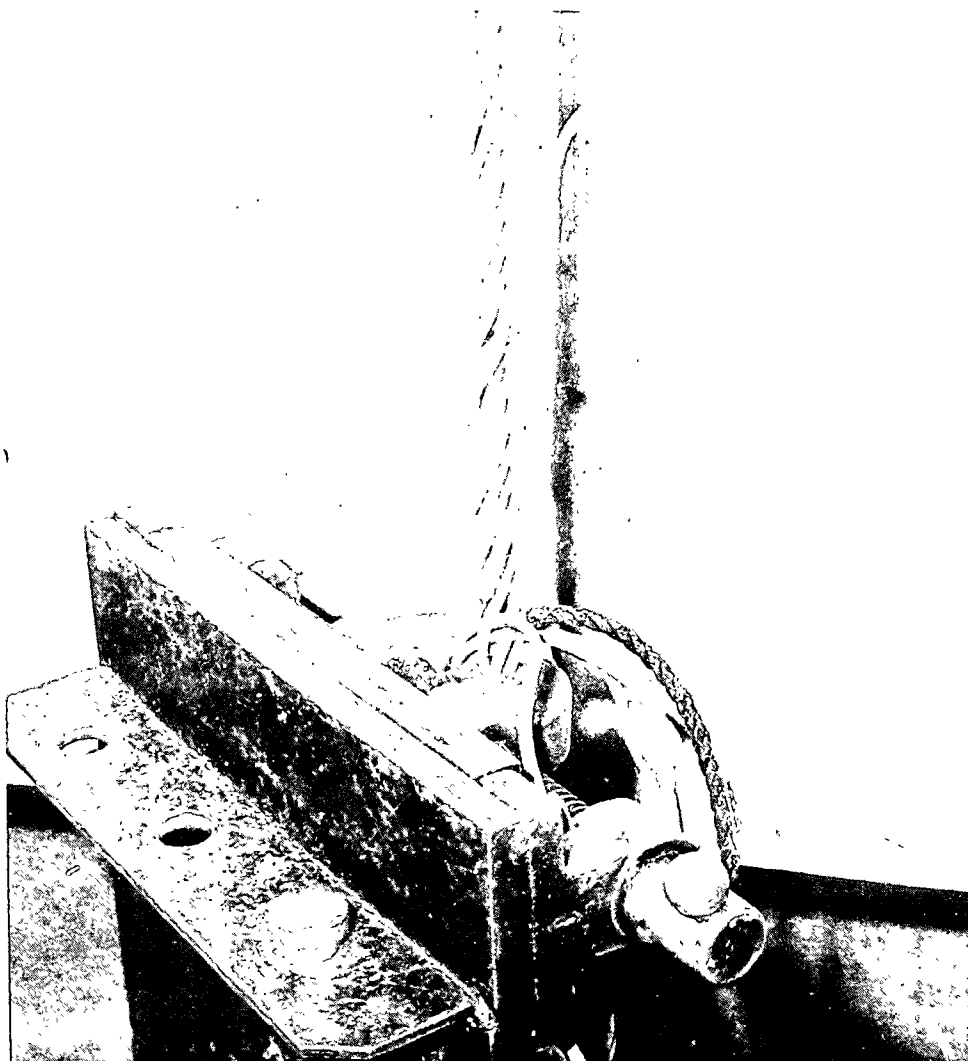


Figure B-1(8). Liverpool splice: number four strand bent up and out of way after its four tucks.

i. Now reinsert the spike one strand up on the standing part from number four tuck. Insertion is again under one strand only, as per the formula. Now, run the spike up three-fourths of a turn and tuck and lock strand number five in place four times, in the same manner as strand number four.

j. Tuck strand number six and lock it in place four times in the same manner as strands four and five (fig B-1(9)).

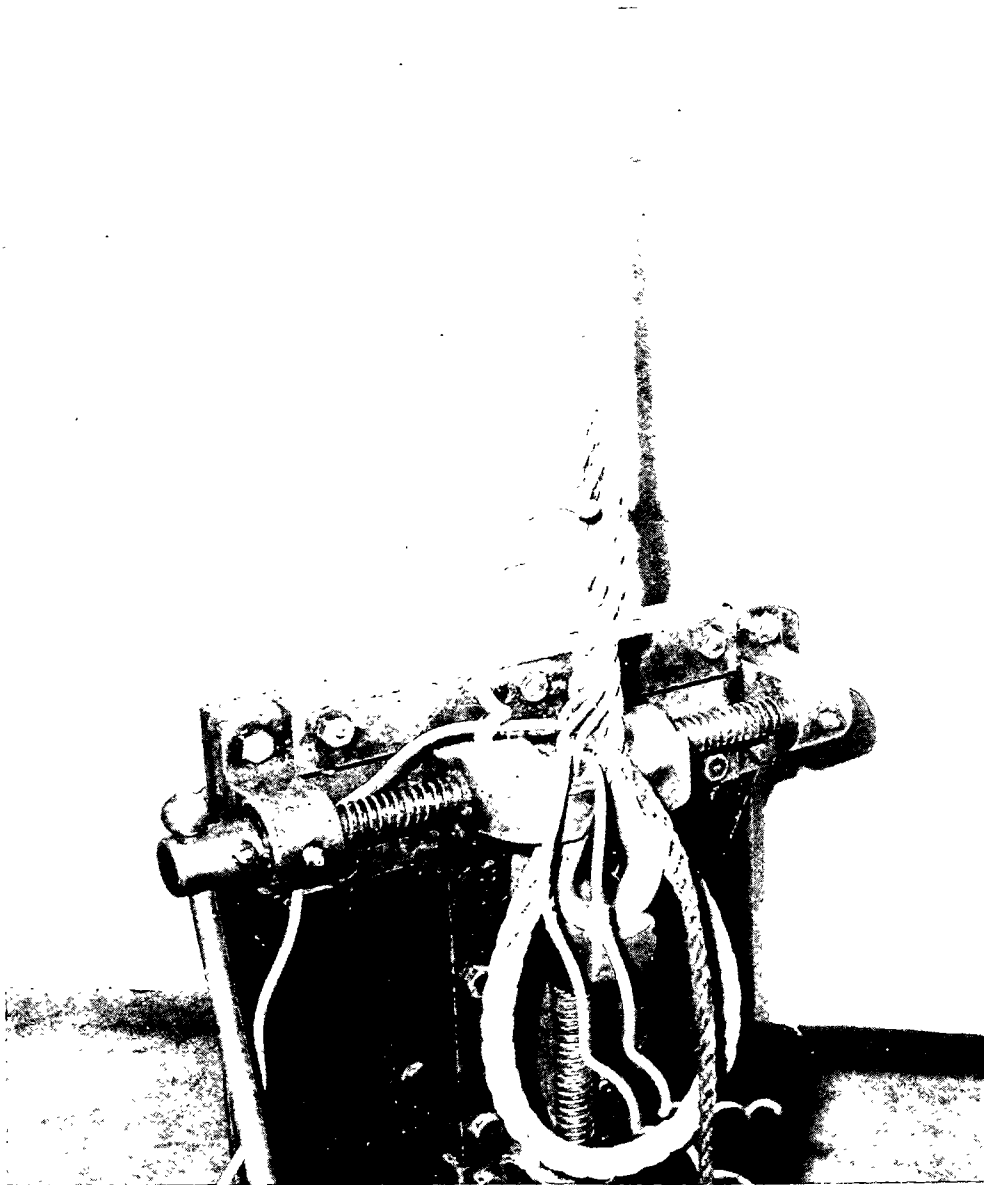


Figure B-1(9). Liverpool splice: strands five and six now tucked and locked in place.

k. Now bury the core in the following manner. Run the spike through the same three strands on the standing part that strand number one was passed through. Take the spike in the left hand and the core in the right. Move the spike to the left and down, pull up on the core with the right hand, and move the spike back to the right (fig B-

1(10)). Raise the spike until it is parallel to the ground and run it up the standing part to a point just at or a little above where strands four, five, and six had their tucks completed (fig B-1(11)). The core will bury itself in the splice as the spike is run up. Remove the spike and cut off the excess core.

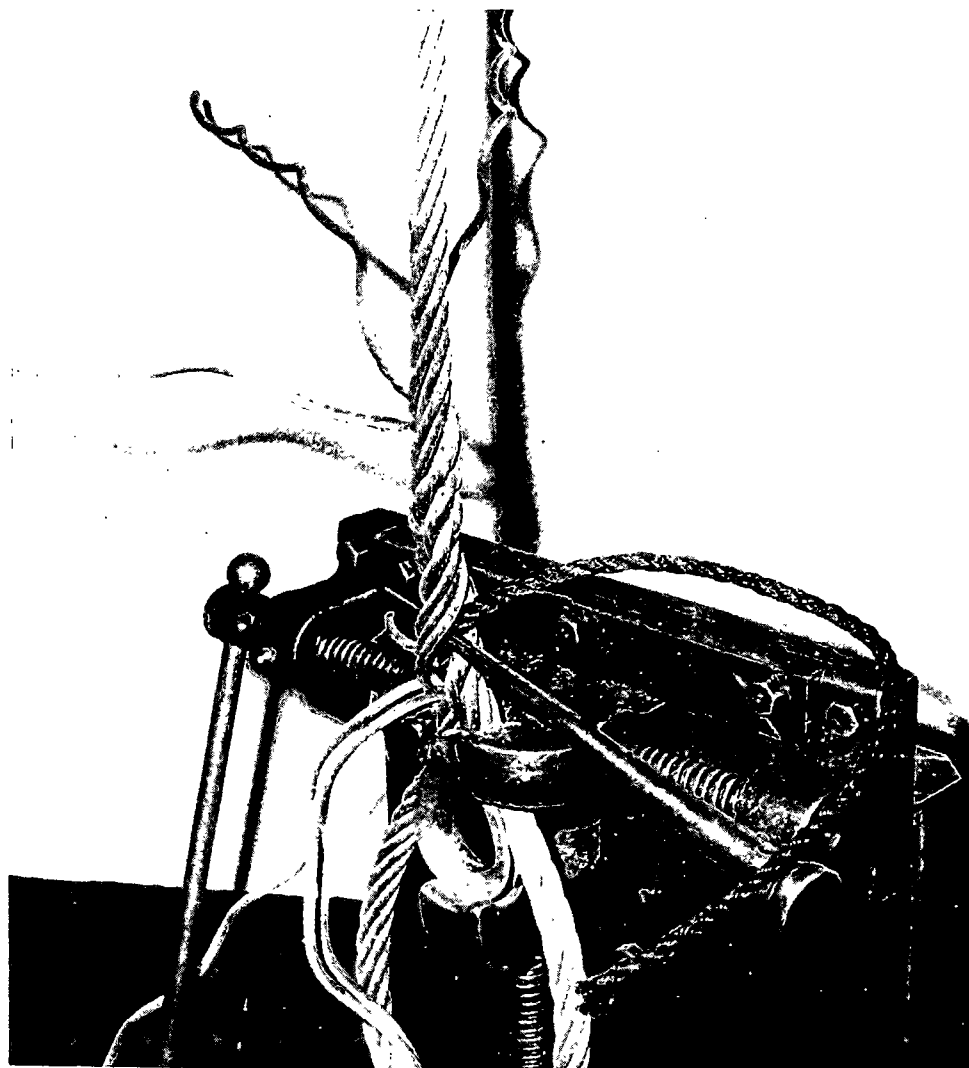


Figure B-1(10). Liverpool splice: core ready for burying.

1. The rope is held taut by a metal clamp or vise.

2. The splice is a complex knot where the rope is folded back on itself and secured with several turns of the rope.

3. The rope is held taut by a metal clamp or vise.

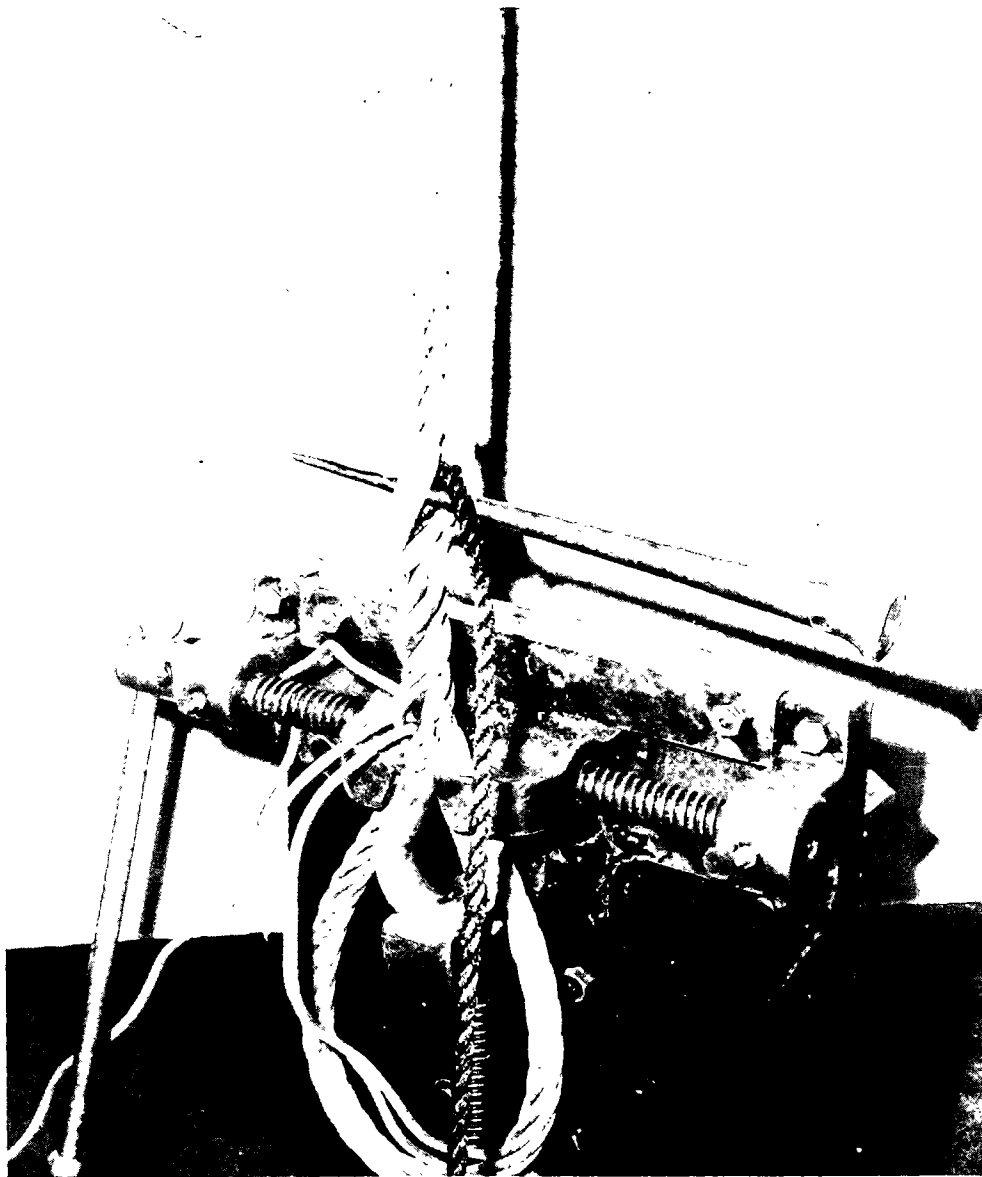


Figure B-1(11). Liverpool splice: core has been buried.

l. Number one strand's tucks are completed next. Insert the spike above number one strand and pick up the strand immediately to its left on the standing part. Run the spike up the standing part until the heel of the spike is directly above strand one. Tuck number one strand under the spike, hold it down, and run the spike down to the starting point and back up, thus locking number one strand's second tuck (overall) in place. Without removing the spike, perform the same process for tucks three and four, then remove the spike.

m. Insert the spike over number two strand, picking up on the strand immediately to its left on the standing part. Take number two strand's last three tucks in the same manner as were number one strand's.

n. Follow the same procedure for number three strand. This completes the Liverpool splice (fig B-1(12)). Cut the loose strands off the wire rope near the standing part and remove the splice from the verticle vise.

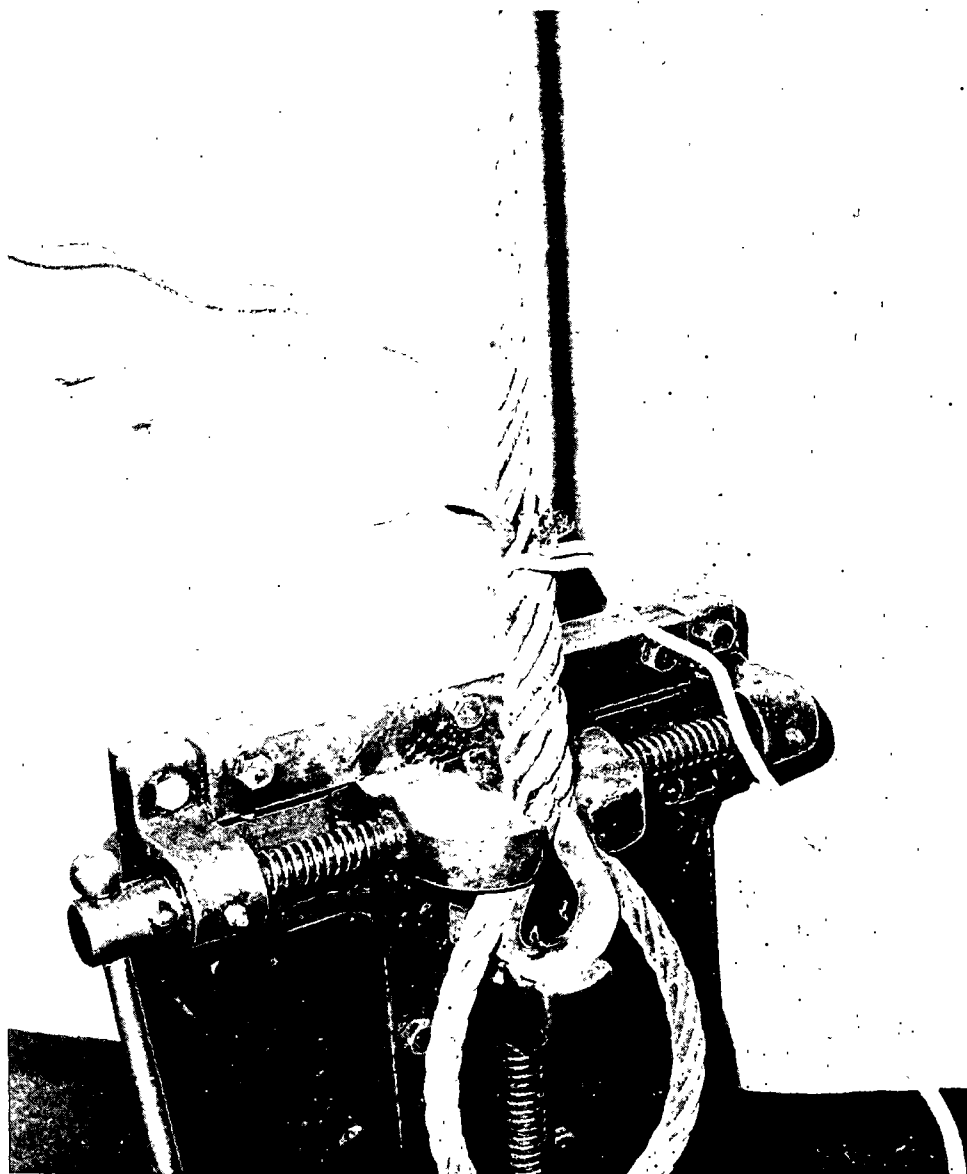


Figure B-1(12). Liverpool splice: complete and ready for loose strands to be clipped off.

B-3. Clips

a. Wire rope clips (fig B-2) are reliable and durable. They can be used repeatedly in making eyes in wire rope, either for a simple eye or for an eye reinforced with a thimble. The clips should be spaced about two rope circumferences apart (i.e., six-rope diameters). The number of clips to be installed is equal to three times the diameter of the rope plus one (i.e., number of clips = $3D + 1$). Thus, a 1-inch rope requires four clips. When this calculation results in a fraction, the next larger whole number is used. In addition, if wire

rope has an Independent Wire Rope Core (IWRC), add an extra clip. After all clips are installed, the clip farthest from the thimble is tightened with a wrench. Then the rope is placed under tension and the nuts are tightened on the clip next to the first clip. The remaining clips are tightened in order, moving toward the thimble. After the rope has been placed in service and has been under tension, the nuts should be tightened again to compensate for any decrease in rope diameter caused by the load. For this reason, clips should never be placed underground.

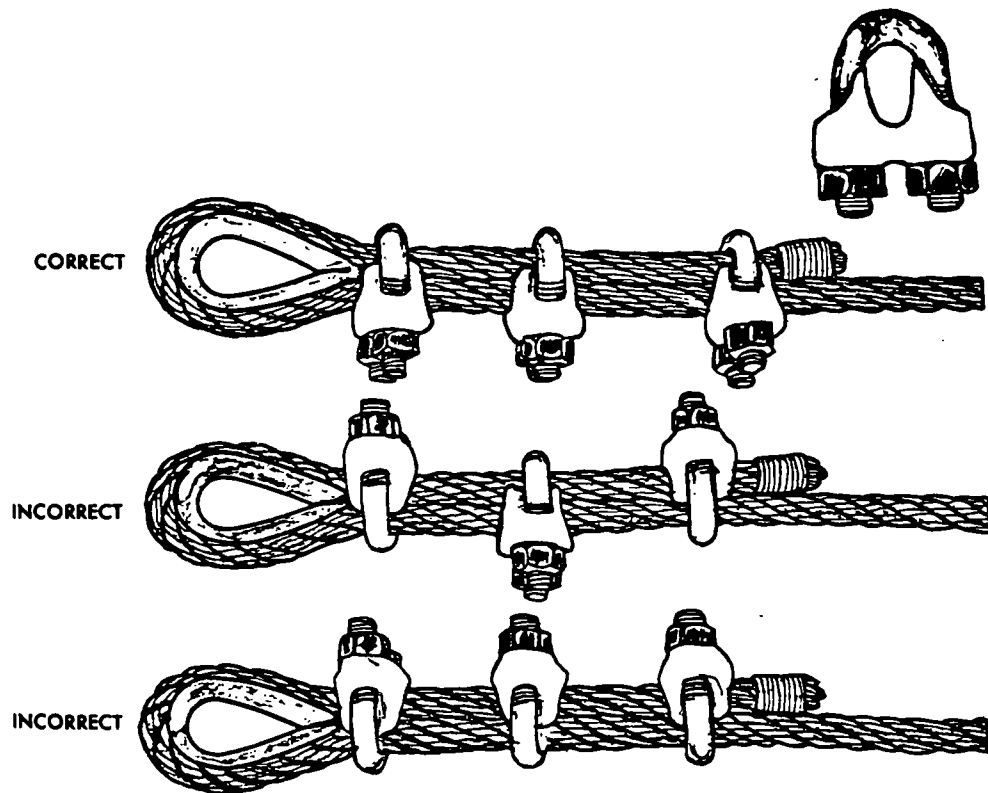


Figure B-2. Wire rope clips.

b. The improved type of wire rope clip shown in figure B-3 is sometimes available to military cargo handlers. It has a few advantages over the older type shown in figure B-2. Both halves are

identical and provide a bearing surface for both parts of the rope. Thus, it cannot be put on incorrectly, and it does not distort the wire. It allows a full swing with a wrench.

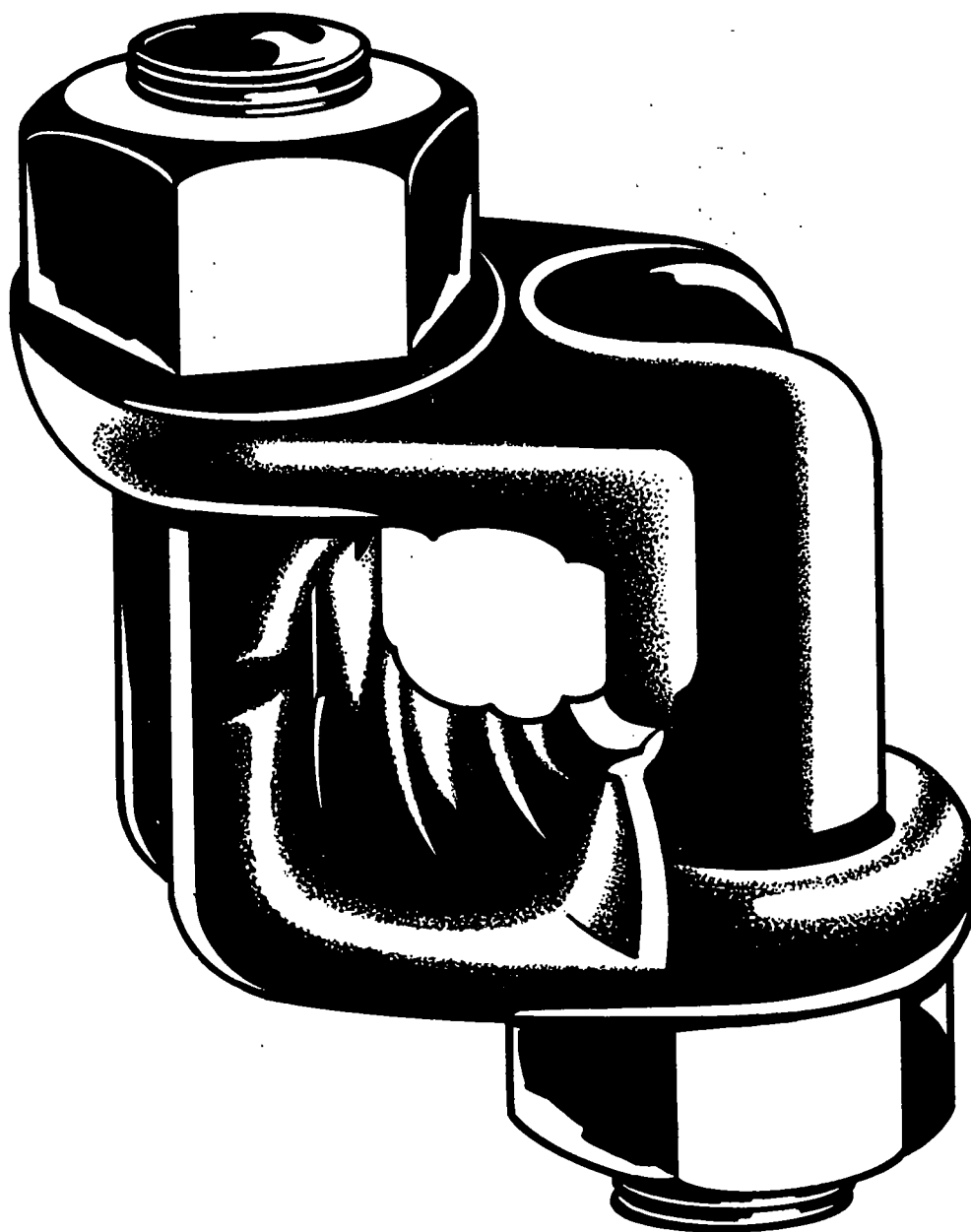


Figure B-3. Improved wire rope clip.

B-4. Blocks and Tackle

Blocks and tackle are essential for moving, lifting, and stowing heavy cargo. A block (A, fig B-4) consists essentially of a wood or metal frame containing one or more rotating pulleys called sheaves. A tackle is an assembly of ropes and blocks used to multiply force (B, fig B-4). The number of times the force is multiplied is the mechanical advantage of the tackle. To make up a tackle system, the blocks to be used are laid out and the rope is reeved (threaded) through the blocks. A simple tackle is one or more blocks

reeved with a single rope. A compound tackle is two or more blocks reeved with more than one rope. Compound tackles, which are infrequently used by military cargo handlers, are described in TM 5-725. Every tackle system contains a fixed block attached to some solid support and may have a traveling block attached to the load. The single rope leaving the tackle system is called the fall line or the hauling part. The pulling force is applied to the fall line, which may be led through a leading block. This is an additional block used to change the direction of pull.

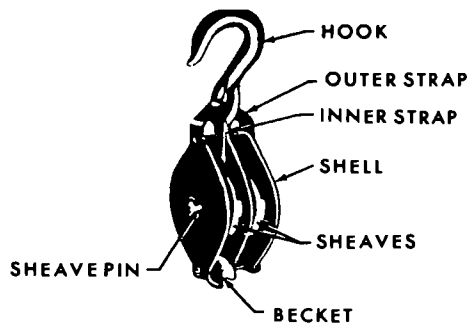
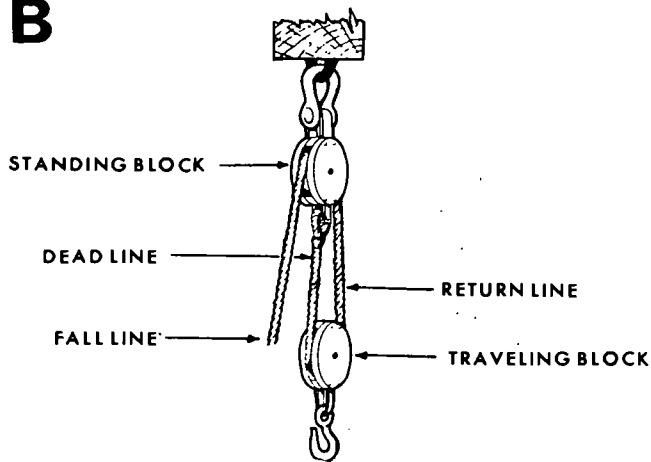
A**B**

Figure B-4. Double block (A) and a tackle system (B).

a. *Blocks.* Blocks are used to reverse the direction of rope in tackle. Blocks (fig B-5) take their names from the purpose for which they are used, from the places they occupy, or from a particular shape or type of construction. According to the number of sheaves, blocks are designated as single, double, or triple. A snatch block is a single sheave block designed to allow the shell to open on one side at the base of the hook, permitting a rope to be slipped over the sheave without threading the end of it through the block. Snatch blocks ordinarily are used where it is necessary to change the direction of the pull on the line. A traveling block is a block attached to the load which is being lifted and which moves as the load is lifted. A standing block is a block that is fixed to a stationary object.

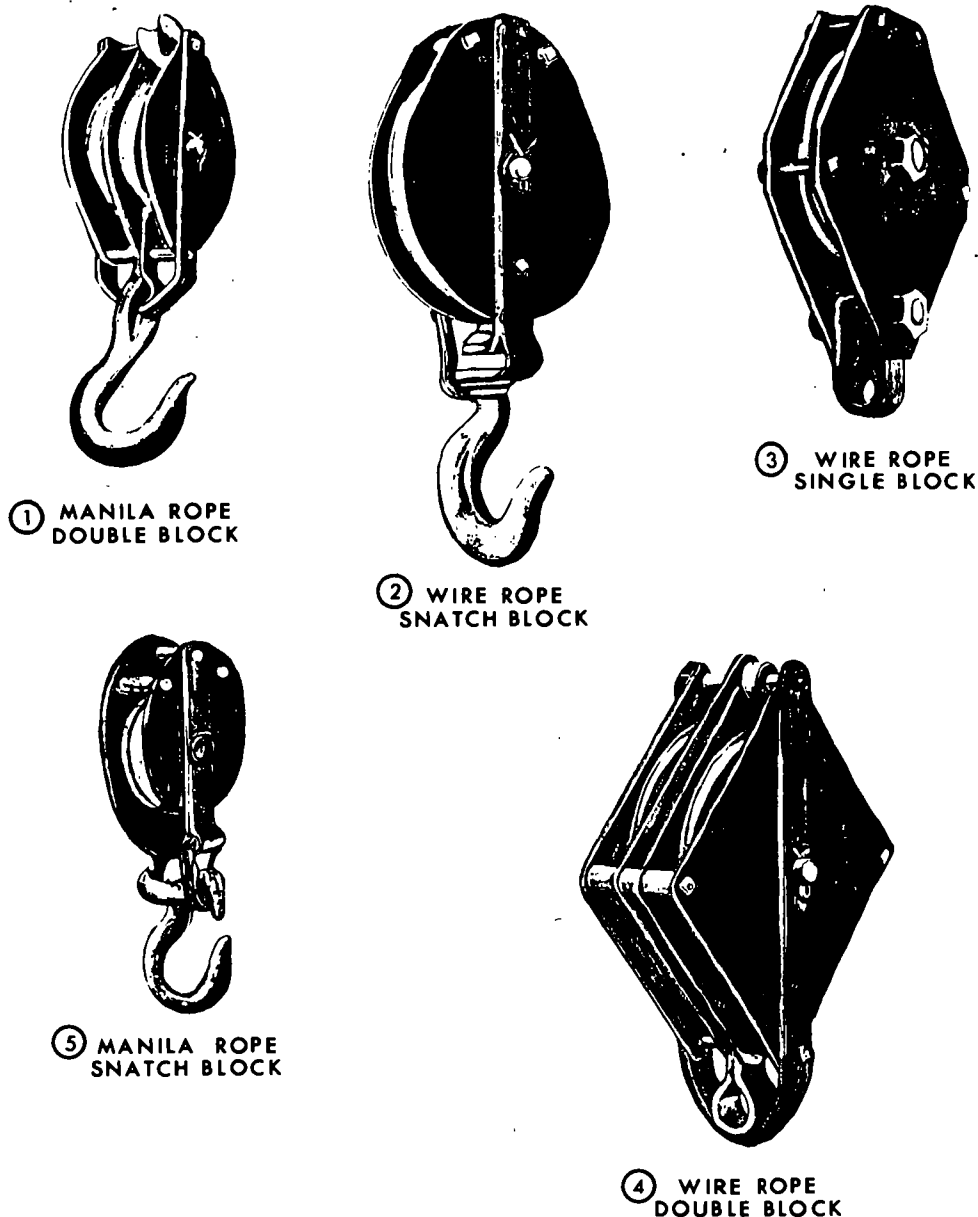


Figure B-5. Types of blocks.

(1) *Leading blocks.* Blocks used in the tackle to change the direction of the pull without affecting the mechanical advantage of the system are called leading blocks (fig B-6). In some tackle systems the fall line leads off the last block in a direction which makes it difficult to apply the

motive force required. A leading block is used to correct this. Ordinarily a snatch block is used as the leading block. This block can be placed at any convenient position. The fall line from the tackle system is led through the leading block to the line of most direct action.

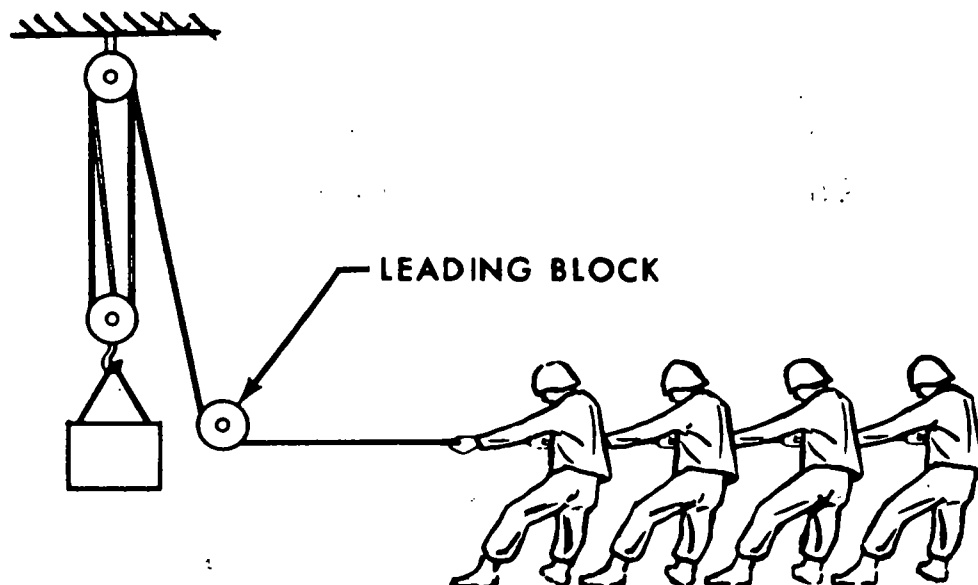


Figure B-6. Use of a leading block.

(2) *Reeving blocks.* Blocks are laid out for reeving on a clean and level surface other than the ground to avoid getting dirt into the operating parts. Figure B-7 shows the reeving of single and double blocks. In reeving triple blocks (fig B-8), it is imperative that the hoisting strain be put at the center of the blocks to prevent them from being inclined under the strain. If the blocks do incline, the rope will drag across the edges of the sheaves and the shell of the block and cut the fibers. The blocks are placed so that the sheaves in one block are at right angles to the sheaves in the other block. The coil of rope may be laid beside either block. The running end is passed down through

the center sheave of one block and back to the bottom sheave of the other block. It is then passed over one of the side sheaves of the first block. In selecting which side sheave over which to pass the rope, it must be remembered that the rope should not cross the rope leading away from the center sheave of the first block. The rope is then led over the top sheave of the second block and back to the remaining side sheave of the first block. From this point, the rope is led to the center sheave of the second block and back to the becket of the first block. The rope should be reeved through the blocks so that no part of the rope chafes another part of the rope.

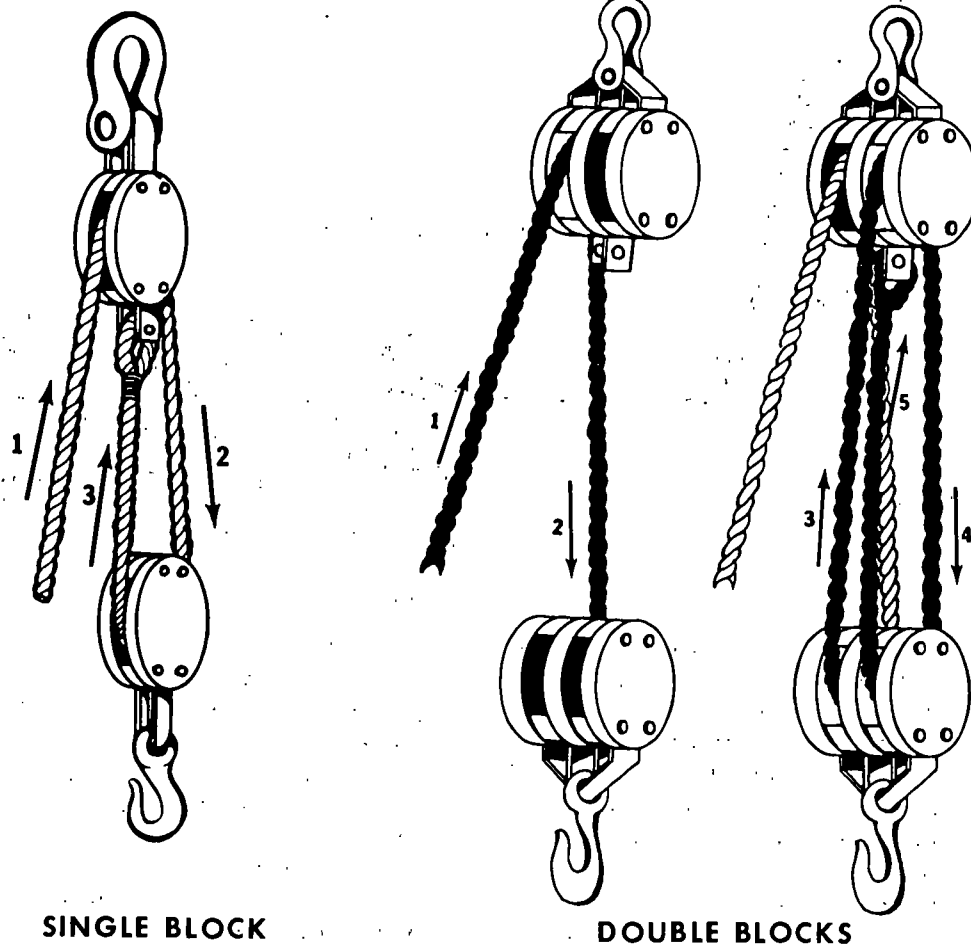


Figure B-7. Reeving single and double blocks.

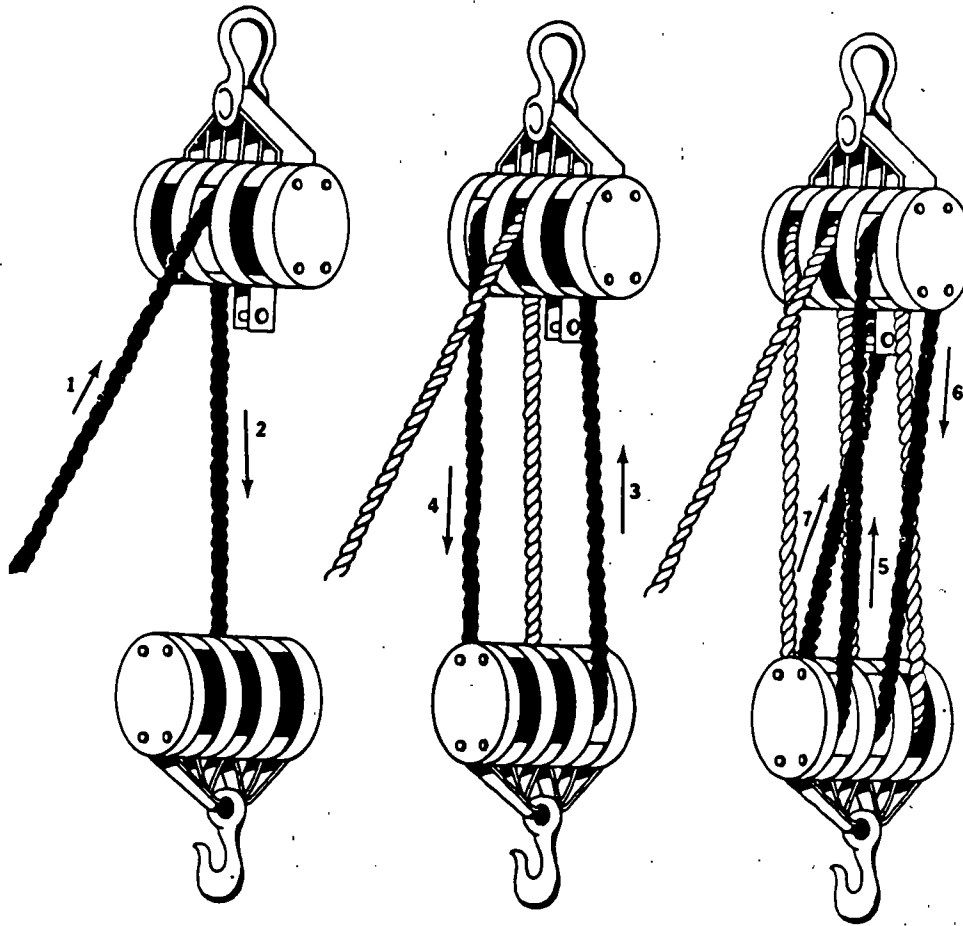


Figure B-8. Reeving triple blocks.

(3) *Twisting.* Blocks should be reeved in a manner that prevents twisting. After the blocks are reeved, the rope should be pulled back and forth through the blocks several times to allow the rope to adjust to the blocks. This reduces the tendency of the tackle to twist under a load. When the ropes in a tackle system become twisted, there is an increase in friction and chafing of the ropes, as well as a possibility of jamming the blocks. When the hook of the standing block is fastened to the supporting member, the hook should be turned so that the fall line leads directly to the leading block or to the source of motive power. It is very difficult to prevent the twisting of a traveling block.

b. Simple Tackle Systems. A simple tackle system is one using one rope and one or more blocks. To determine the mechanical advantage of a simple system (fig B-9), count the number of lines supporting the load (or the traveling block). In counting, the fall line is included if it leads out of a traveling block. In a simple tackle system the mechanical advantage always will be the same as the number of lines supporting the load. As an

alternate method, the mechanical advantage can be determined by tracing the forces through the system. Thus, begin with a unit force applied to the fall line. Assume that the tension in a single rope is the same throughout, and therefore, the same force will exist in each line. Total all the forces acting on the load or traveling block. The ratio of the resulting total force acting on the load or traveling block to the original unit force exerted on the fall line is the theoretical mechanical advantage of the simple system.

Examples:

Method I. Counting supporting lines. In 1, figure B-10, there are three lines supporting the traveling block, so the theoretical mechanical advantage is 3:1.

Method II. Unit force. Assuming the tension on a single rope is the same throughout its length, a unit force of 1 on the fall line results in a total of 3 unit forces acting on the traveling block (2, fig B-10). The ratio of the resulting force of 3 on the traveling block to the unit force of 1 on the fall line gives a theoretical mechanical advantage of 3:1.

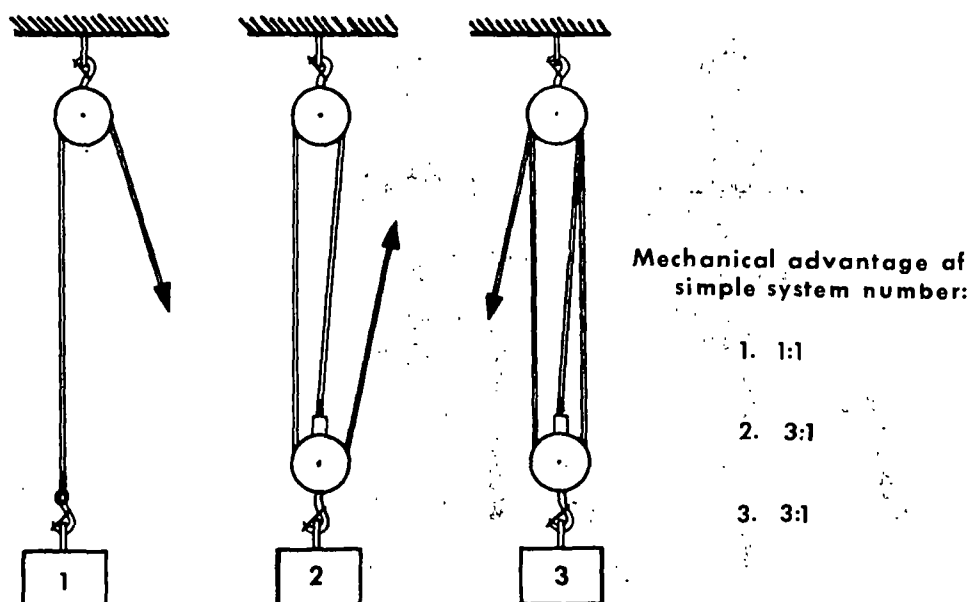


Figure B-9. Simple tackle systems

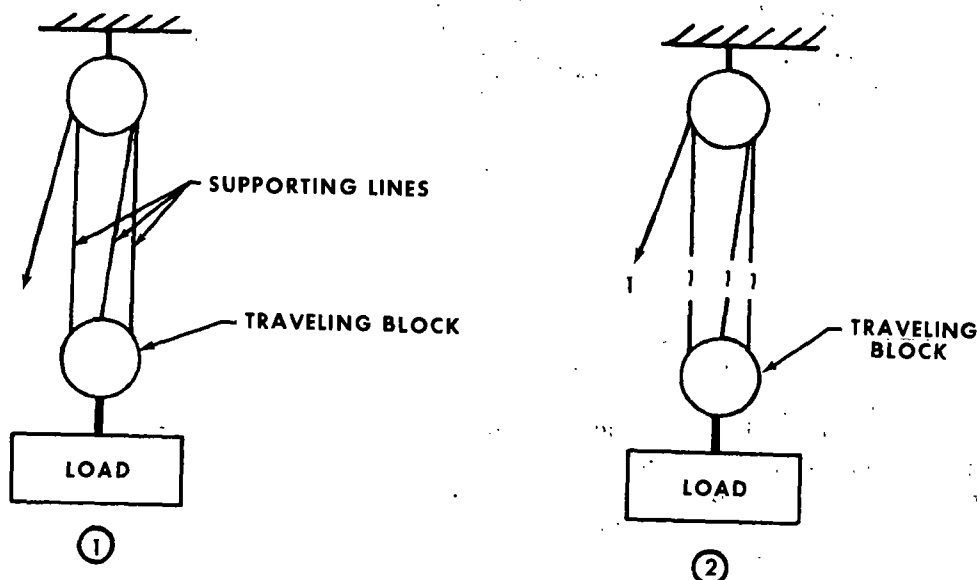


Figure B-10. Determining ratio of a simple tackle.

B-5. Useful Formulas for Working With Fiber and Wire Rope

Due to different manufacturers' construction methods, the same sizes of fiber and wire rope may differ in safe working loads and breaking strengths. Thus, a set of useful formulas has been devised for working with these ropes, no matter who the manufacturer. Tables B-1 and B-2 provide the safe working load and breaking strength of fiber rope and wire ropes (improved plow steel). Similarly, estimation of the capacities of other elements of rigging gear, including hooks, shackles, chain, and lifting rings, is given

here. For safety reasons, main emphasis should be given to the safe working load in rigging, as breaking strength assumes perfection in the condition of all involved equipment and the use thereof.

a. The following abbreviations are used in the formulas given:

C = circumference
 D = diameter
 BS = breaking strength (or stress)
 SWL = safeworking load
 SF = safety factor (5 is general in the marine field)

L = load

S/T = short tons (2,000 pounds)

lb = pounds

Note. Where needed, the appropriate constant for each figure must be used, as shown below (e.g., fiber rope, manila: 200; fiber rope, sisal: 160).

b. The following are formulas for working with fiber and wire rope:

(1) *Fiber rope, manilla.*

$$SWL = C^2 \times 200 = lb$$

$$BS = SWL \times SF = lb$$

Example: Find SWL and BS of 3" C manila.

$$\text{Manufacturers BS} = 9,000 \text{ pounds}$$

$$SWL = 3 \times 3 \times 200 = 1,800 \text{ pounds}$$

$$BS = 1,800 \times 5 = 9,000 \text{ pounds}$$

(2) *Fiber rope, sisal.*

$$SWL = C^2 \times 160 = lb$$

$$GS = SWL \times SF = lb$$

Example: Find SWL and BS of 3" C sisal.

$$\text{Manufacturers BS} = 7,200 \text{ pounds}$$

$$SWL = 3 \times 3 \times 160 = 1,440 \text{ pounds}$$

$$BS = 1,440 \times 5 = 7,200 \text{ pounds}$$

(3) *Fiber rope, nylon, 3-strand filament.*

$$SWL = C^2 \times 500 = lb$$

$$BS = SWL \times SF = lb$$

Example: Find SWL and BS of 3" C nylon, 3-strand filament.

$$\text{Manufacturers BS} = 25,000 \text{ pounds}$$

$$SWL = 3 \times 3 \times 500 = 4,500 \text{ pounds}$$

$$BS = 4,500 \times 5 = 22,500 \text{ pounds}$$

(4) *Fiber rope, nylon, 2-in-1, stable braid.*

$$SWL = C^2 \times 600 = lb$$

$$BS = SWL \times SF = lb$$

Example: Find SWL and BS of 3" C nylon, 2-in-1, stable braid.

$$\text{Manufacturers BS} = 28,000 \text{ pounds}$$

$$SWL = 3 \times 3 \times 600 = 5,400 \text{ pounds}$$

$$BS = 5,400 \times 5 = 27,000 \text{ pounds}$$

Note. Where nylon is used to a maximum strain, it is recommended that the safety factor (SF) be raised to 9. New 3-strand nylon rope can be stretched safely about 40 percent but will part at 50 percent. New 2-in-1 nylon rope with a stretch factor of approximately 15 to 20 percent under heavy loads is safer than the 3-strand rope. The lower stretch factor of the 2-in-1 nylon rope results in less backlash.

Table B-1. Breaking Strength and Safe Working Load of Fiber Line

Nominal diameter (inches)	Circumference (inches)	Manila		Sisal		Fiber rope, nylon, 3 strand		Fiber rope, nylon, 2-in-1, Stable braid	
		Breaking strength (lb)	Safe working load (lb)	Breaking strength (lb)	Safe working load (lb)	Breaking strength (lb)	Safe working load (lb)	Breaking strength (lb)	Safe working load (lb)
1/4	3/4	560	110	450	90	1,400	280	1,675	335
3/8	1 1/8	1,265	250	1,010	200	3,150	630	3,775	755
1/2	1 1/2	2,250	450	1,800	360	5,625	1,125	6,750	1,350
5/8	2	4,000	800	3,200	640	10,000	2,000	12,000	2,400
3/4	2 1/4	5,000	1,000	4,050	810	12,650	2,530	15,180	3,035
7/8	2 3/4	7,560	1,510	6,050	1,210	18,900	3,780	22,680	4,535
1	3	9,000	1,800	7,200	1,440	22,500	4,500	27,000	5,400
1 1/8	3 1/2	12,250	2,450	9,800	1,960	30,625	6,125	36,750	7,350
1 1/4	3 3/4	14,000	2,800	11,200	2,240	35,150	7,030	42,180	8,435
1 1/2	4 1/2	20,250	4,050	16,200	3,240	50,625	10,125	60,750	12,150
1 3/4	5 1/2	30,250	6,050	24,200	4,840	75,625	15,125	90,750	18,150
2	6	36,000	7,200	28,800	5,760	90,000	18,000	108,000	21,600
2 1/2	7 1/2	56,250	11,250	45,000	9,000	140,625	28,125	168,750	33,750
3	9	81,000	16,200	64,800	12,960	202,500	40,500	243,000	48,600

(5) *Wire Rope*. This is measured by its diameter, whereas fiber rope is measured by circumference. The wire rope used extensively by the military is preformed improved plow steel.

(a) *Extra improved plow steel.*

$$SWL = D^2 \times 10 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of 1" diameter, 6 x 19, extra improved plow steel.

$$\text{Manufacturers BS} = 51.7 \text{ S/T}$$

$$SWL = 1 \times 1 \times 10 = 10 \text{ S/T}$$

$$BS = 10 \times 5 = 50 \text{ S/T}$$

(b) *Improved plow steel (widely used by the military).*

$$SWL = D^2 \times 8 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of 1" diameter, 6 x 19, improved plow steel.

$$\text{Manufacturers BS} = 41.8 \text{ S/T}$$

$$SWL = 1 \times 1 \times 8 = 8 \text{ S/T}$$

$$BS = 8 \times 5 = 40 \text{ S/T}$$

(c) *Plow steel.*

$$SWL = D^2 \times 7 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of 1" diameter, 6 x 19, plow steel.

$$\text{Manufacturers BS} = 36.4 \text{ S/T}$$

$$SWL = 1 \times 1 \times 7 = 7 \text{ S/T}$$

$$BS = 7 \times 5 = 35 \text{ S/T}$$

(d) *Mild plow steel.*

$$SWL = D^2 \times 6 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of 1" diameter, 6 x 19, mild plow steel.

$$\text{Manufacturers BS} = 31.6 \text{ S/T}$$

$$SWL = 1 \times 1 \times 6 = 6 \text{ S/T}^*$$

$$BS = 6 \times 5 = 30 \text{ S/T}$$

*The SF is greater than 5 and gives a greater margin of safety.

Table B-2. Safe Working Load and Breaking Strength of Improved Plow Steel Wire (6x19) in Short Tons

Diameter (inches)	Safe working load (S/T)	Breaking strength (S/T)
1/4	.5	2.5
3/8	1.12	5.62
1/2	2.0	10.00
5/8	3.12	15.62
3/4	4.5	22.5
7/8	6.12	30.62
1	8.0	40.0
1 1/8	10.12	50.62
1 1/4	12.5	62.5
1 1/2	18.0	90.0
1 3/4	24.5	122.5
2	32.0	160.0

(6) *Hooks.*

$$SWL = D^2 \times 2/3 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of a 1" diameter hook, standard eye.

Manufacturers rated SWL = .56 S/T using a safety factor of 6

$$SWL = 1 \times 1 \times 2/3 = .66 \text{ S/T}$$

$$\text{Manufacturers BS} = .56 \times 6 = 3.36 \text{ S/T}$$

$$\text{Using SF of 5, BS} = .66 \times 5 = 3.30 \text{ S/T}$$

(7) *Shackles and chain.*

$$SWL = D^2 \times 6 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of an anchor or chain shackle, 1" diameter.

$$\text{Manufacturers SWL} = 6.5 \text{ S/T}$$

$$SWL = 1 \times 1 \times 6 = 6 \text{ S/T}$$

$$BS = 6 \times 5 = 30 \text{ S/T}$$

(8) *Lifting rings (use SF of 6).*

(a) *Pear-shaped links.*

$$SWL = D^2 \times 3 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of a pear-shaped link, 1" diameter.

Manufacturers SWL = 3.1 S/T (SF is 6)

$$SWL = 1 \times 1 \times 3 = 3 \text{ S/T}$$

$$BS = 3 \times 6 = 18 \text{ S/T}$$

(b) *Ring type (oval).*

$$SWL = D^2 \times 2.5 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of a ring type (oval), 1" diameter.

$$\text{Manufacturers SWL} = 2.5 \text{ S/T}$$

$$SWL = 1 \times 1 \times 2.5 = 2.5 \text{ S/T}$$

$$BS = 2.5 \times 6 = 15 \text{ S/T (SF is 6)}$$

(c) *Oblong links.*

$$SWL = D^2 \times 5 = S/T$$

$$BS = SWL \times SF = S/T$$

Example: Find SWL and BS of an oblong link, 1" diameter.

$$SWL = 1 \times 1 \times 5 = 5 \text{ S/T}$$

$$BS = 5 \times 6 = 30 \text{ S/T (use a SF of 6 when lifting rings are used)}$$

(9) *Selecting proper size.* When determining the proper size of fiber, wire rope, or chain required to lift a given load safely, the load must be converted to short tons (S/T) for these formulas.

(a) *Manila.*

$$C = \sqrt{L \times 15}$$

Example: Determine C of manila to safely lift 2.5 S/T.

$$C = \sqrt{2.5 \times 15} = \sqrt{37.50} = 6.1'';$$

use 6'' manila (C)

$$\text{Manufacturers BS} = 15.5 \text{ S/T}$$

$$\text{SWL} = 15.5: 6 = 2.6 \text{ S/T (approximately)}$$

Formula safety factor is 6

(b) *Nylon, 3-strand filament.*

$$C = \sqrt{L \times 5}$$

Example: Use same load, 2.5 S/T.

$$C = \sqrt{2.5 \times 5} = \sqrt{12.50} = 3.5''$$

(approximately); use 3½'' C-nylon, 3-strand

$$\text{Manufacturers BS} = 16.5 \text{ S/T}$$

$$\text{SWL} = 16.5: 6 = 2.7 \text{ S/T (approximately)}$$

Formula safety factor is 6

(c) *Wire rope.*

$$C = \sqrt{L \times 1.5}$$

Example: Determine size of improved plow steel wire to lift 2.5 S/T.

$$C = \sqrt{2.5 \times 1.5} = \sqrt{3.75} = 1.9'' \text{ C}$$

(wire size is measured by diameter)

$$D = 1.9'' \div 3.14 = .605'' \text{ or } .61'' = 9/16''$$

(which is the next largest standard size of wire rope).

$$\text{Manufacturers BS} = 14.5 \text{ S/T}$$

$$\text{SWL} = 14.5: 6 = 2.4 \text{ S/T}$$

Formula safety factor is 6

(d) *Shackles or chain.*

$$D = \sqrt{\frac{\text{BS}}{30}}$$

Example: Find size shackle required to lift 2.5 S/T safely.

$$\text{BS} = \text{SWL} \times \text{SF} = \text{S/T}$$

$$\text{BS} = 2.5 \text{ S/T} \times 5 (\text{SF}) = 12.50 \text{ S/T}$$

$$D = \sqrt{\frac{12.50}{30}} = .64'' = 3/4''$$

(which is the next largest standard size of wire rope)

$$\text{Manufacturers SWL of } 3/4'' = 3.2 \text{ S/T}$$

$$\text{SWL of } 5/8'' = 2.2 \text{ S/T}$$



APPENDIX C

CONVERSION FACTORS

C-1. Introduction

Terminal operations personnel must be able to solve various types of mathematical problems that arise pertaining to the proper and effective handling, stowing, shipping, etc., of military

cargo. To make this task easier and to insure correct answers and results, numerous tables are available. Basic conversion tables are included in this appendix.

Table C-1. Linear Measurement

Meters *	Inches	Feet	Yards	Statute	Miles Nautical	Kilometers	Fathoms
1.0	39.37	3.28083	1.09361	0.0006214	0.0005396	0.001	0.546
.0254	1.0	.0833	.0278	.00001578	.00001371	.0000254	.0139
.3048	12.0	1.0	.3333	.0001894	.0001645	.0003048	.167
.9144	36.0	3.0	1.0	.0005682	.0004934	.0009144	.500
5.0292	198.0	16.5	5.5	.003125	.002714	.005029	2.76
20.1168	792.0	66.0	22.0	.0125	.01085	.02012	11.0
1,609.35	63,360.0	5,280.0	1,760.0	1.0	.8684	1.6094	879.0
1,853.25	72,962.5	6,080.2	2,026.73	1.15155	1.0	1.85325	1,010.0
1,000.0	39,370.0	3,280.83	1,093.61	.6214	.5396	1.0	546.0
219.5	8,640.0	720.0	240.0	.1364	.1184	.2195	120.0
1.829	72.0	6.0	2.0	.00114	.00098	.00183	1.0

*1 meter = 10 decimeters = 100 centimeters = 1,000 millimeters

** A nautical mile is the length on the earth's surface of an arc subtended by one minute of angle at the center of the earth. Therefore, the circumference of the earth is equivalent in nautical miles to the number of minutes in a circle (360 x 60 = 21,600)

Table C-2. Surface Measurement

Square meters	Square Inches	Square Feet	Square yards	Square rods	Square miles (statute)	Square kilometers
1.0	1,550.0	10.764	1.196	0.03954	0.000000386	0.000001
.00065	1.0	.0069	.00077	.00000026	.0000000025	.0000000065
.0929	144.0	1.0	.1111	.00367	.0000000359	.0000000929
.8361	1,296.0	9.0	1.0	.0331	.000000323	.000000836
25.293	39,204.0	272.25	30.25	1.0	.00000977	.0000253
4,046.8	6,272,640.0	43,560.0	4,840.0	160.0	.00156	.00405
10,000.0	15,499,969.0	107,639.0	11,960.0	395.37	.00386	.01
2,589,999.0	Sq ft x 144	27,878,400.0	3,097,600.0	102,400.0	1.0	2.59
1,000,000.0	Sq ft x 144	10,763,867.0	1,195,985.0	39,537.0	.3861	1.0

Table C-3. Cubic and Volume Measurements

Cubic centimeters	Cubic inches	Cubic feet *	Cubic yards	US gallons		US bushels	Measurement tons
				Liquid	Dry		
1.0	0.001	0.0000353	0.0000013	0.000264	0.000227	0.000028	0.00000088
1,000.0	61.023	.0353	.00131	.2642	.227	.0284	.000882
16.39	1.0	.0005787	.0000214	.00433	.00372	.00465	.0000144
28,317.0	1,728.0	1.0	.03704	7.481	6.4285	.80356	.025
764,559.0	46,656.0	27.0	1.0	201.974	173.57	21.696	.677
946.4	57.75	.03342	.00124	.25	.2148	.02686	.000837
1,101.2	67.201	.03889	.00144	.2909	.24	.0313	.000975
3,785.4	231.0	.13368	.00495	1.0	.8594	.1074	.00335
4,404.9	268.803	.15556	.00576	1.1636	1.0	.125	.00388
35,239.3	2,150.42	1.2445	.0461	9.3092	8.0	1.0	.0312
1,130,000.0	69,120.0	40.0	1.48	298.0			

* A board foot, used in measurements for lumber, measures 12" x 12" x 1". Its volume is 1/12 of a cubic foot.

US dry measure: 1 bushel = 4 pecks = 8 gallons = 32 quarts = 64 pints

US liquid measure: 1 gallon = 4 quarts = 8 pints = 32 gills = 128 fluid ounces = .83268 imperial gallon

Table C-4. Weight Measurement

Kilograms (kg)	Ounces		Pounds		Short (2,000 lb)	Tons long (2,240 lb)	Metric (1,000 kg)
	Troy	Avoirdupois (avdp)	Troy	Avoirdupois (avdp)			
1.0	32.1507	35.274	2.67923	2.20462	0.001102	0.0009842	0.001
.0000648	.002083	.0002286	.0001736	.0001429	.00000007	.00000006	.00000006
.0311	1.0	1.09714	.08333	.06857	.00003429	.00003061	.0000311
.02385	.91146	1.0	.07595	.0625	.00003125	.0000279	.00002835
.37324	12.0	13.1657	1.0	.82286	.0004114	.0003674	.0003732
.45359	14.5833	16.0	1.21528	1.0	.0005	.0004464	.004536
907.185	29,166.7	32,000.0	2,430.56	2,000.0	1.0	.89286	.90719
1,016.05	32,666.7	35,840.0	2,722.22	2,240.0	1.12	1.0	1.01605
1,000.0	32,150.7	35,274.0	2,679.23	2,204.62	1.10232	.98421	1.0



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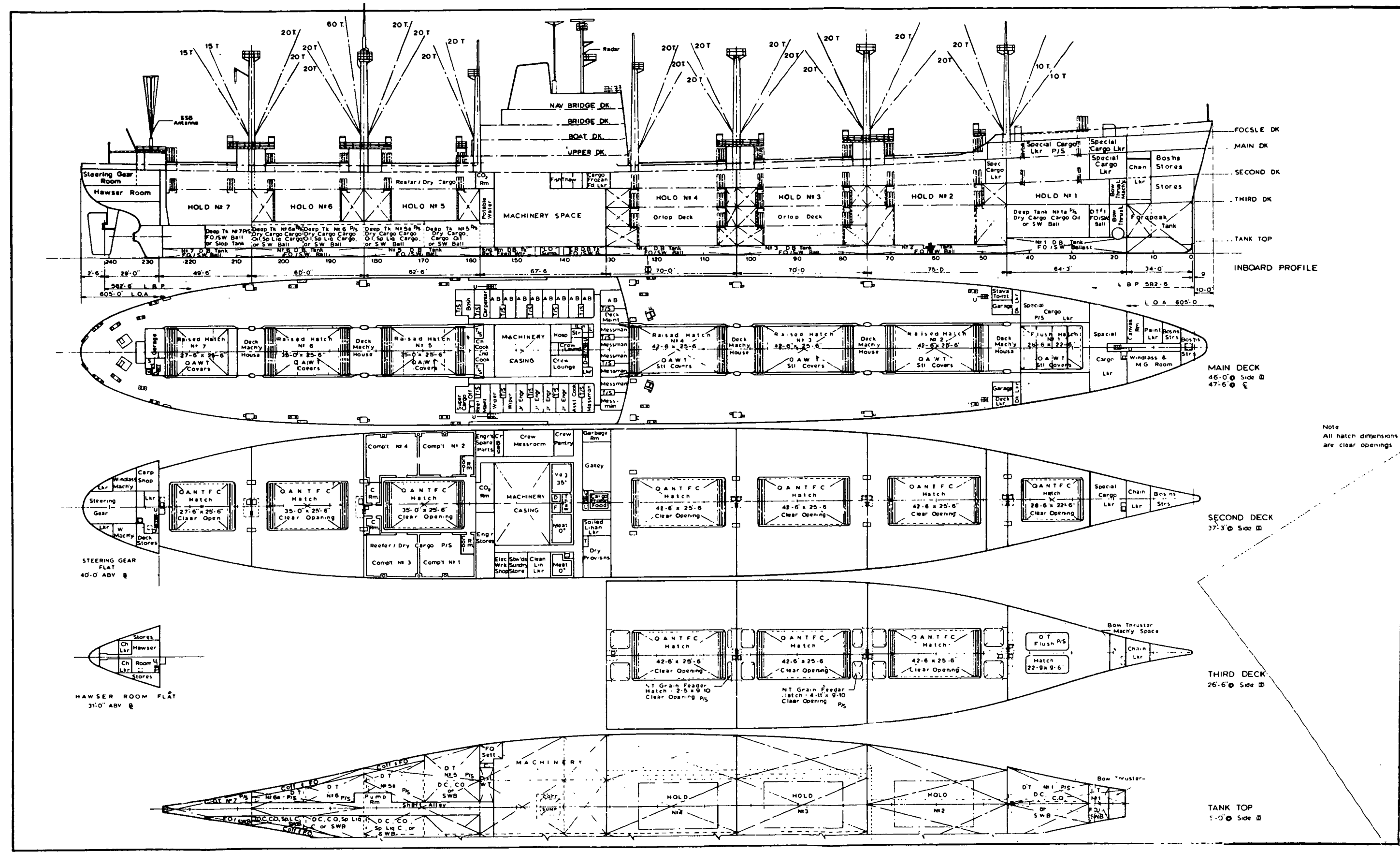


Figure 2-6(1). Partial container ship, C5-S-75a design, profile and deck plans.

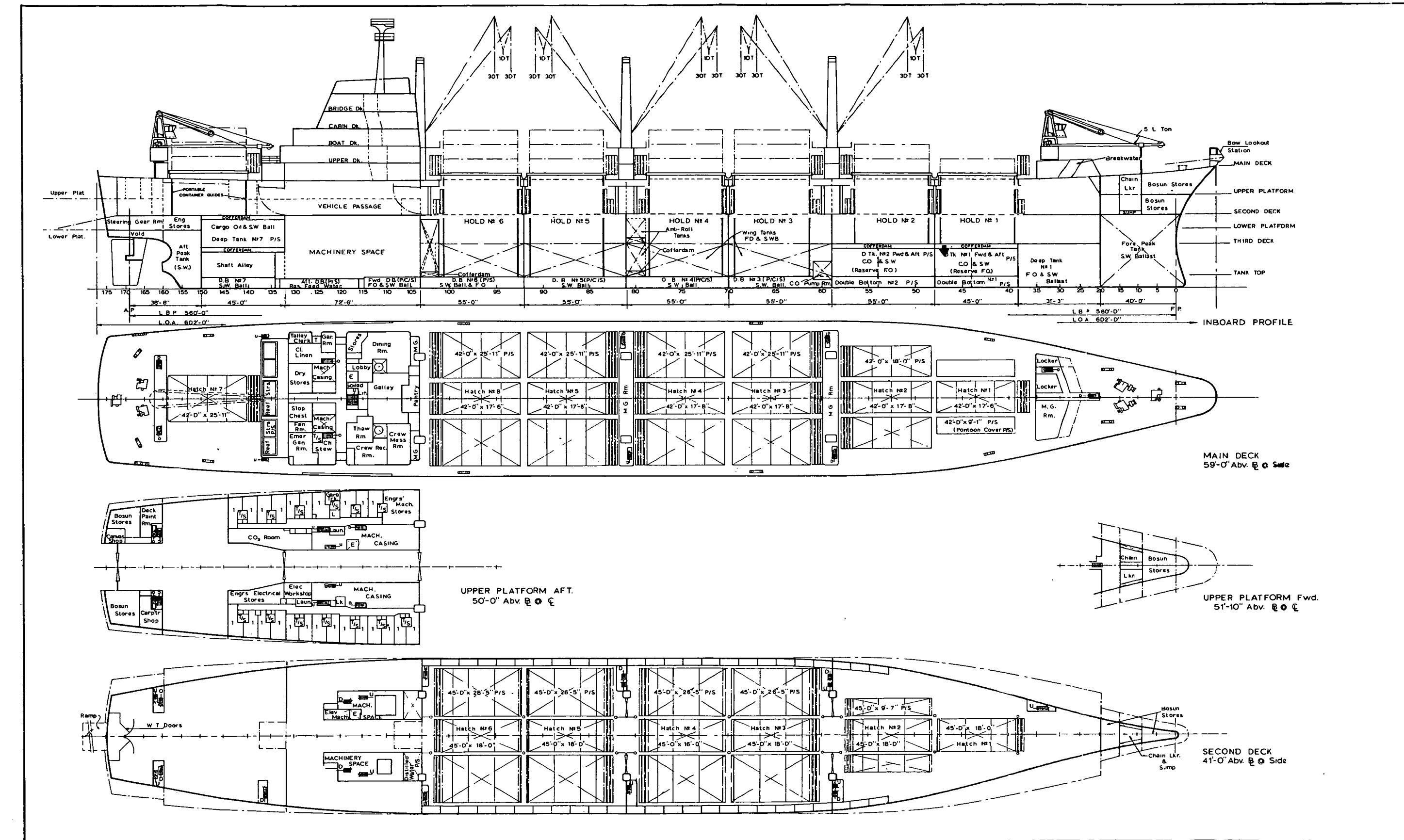
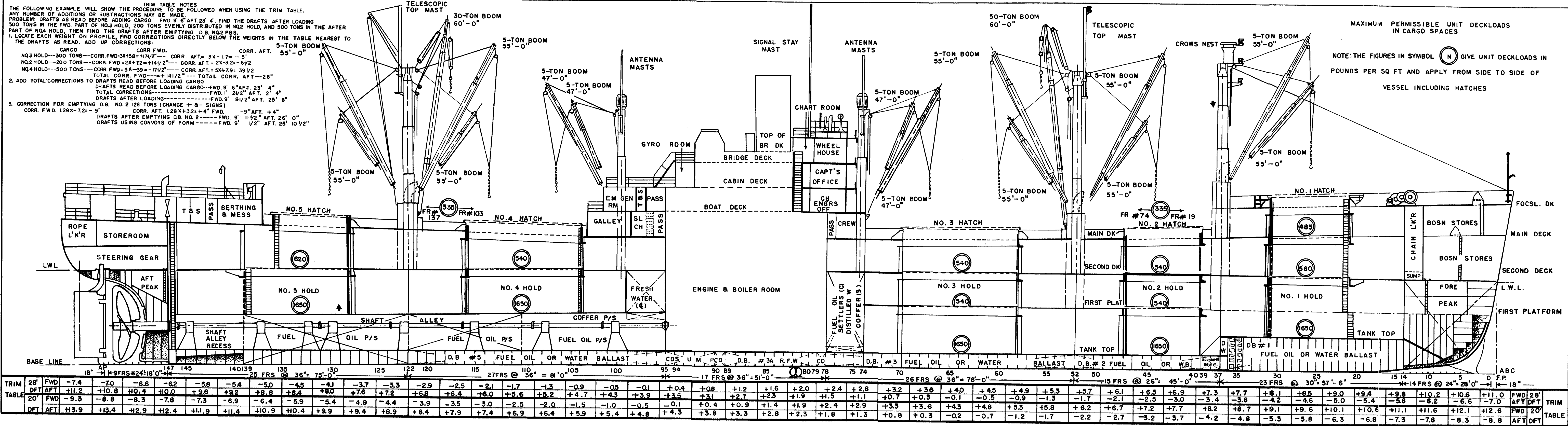


Figure 2-712). C5-S-78a, Sea-Bridge class, profile and deck plans.

CARGO CORR. FWD. CORR. AFT. 510N B
 NQ3 HOLD---300 TONS---CORR. FWD=3X+58=+171/2"--- CORR. AFT.= 3X-1.7=- 5"
 NQ2 HOLD---200 TONS---CORR. FWD=2X+72=+141/2"--- CORR. AFT.= 2X-3.2=- 61/2"
 NQ4 HOLD---500 TONS---CORR. FWD=5X-33=-171/2"--- CORR. AFT.= 5X+7.9= 39 1/2"
 TOTAL CORR. FWD---=+141/2"--- TOTAL CORR. AFT---28"
 2. ADD TOTAL CORRECTIONS TO DRAFTS READ BEFORE LOADING CARGO
 DRAFTS READ BEFORE LOADING CARGO---FWD. 8' 6" AFT. 23' 4"
 TOTAL CORRECTIONS-----FWD. 1' 21/2" AFT. 2' 4"
 DRAFTS AFTER LOADING-----FWD. 9' 81/2" AFT. 25' 8"
 3. CORRECTION FOR EMPTYING D.B. NO. 2 128 TONS (CHANGE + 8- SIGNS)
 CORR. FWD. 1.28X-7.2=- 9" CORR. AFT. 1.28X+3.2=+4" FWD. -9" AFT. +4"
 DRAFTS AFTER EMPTYING D.B. NO. 2-----FWD. 8' 11 1/2" AFT. 26' 0"
 DRAFTS USING CONVOYS OF FORM-----FWD. 9' 1/2" AFT. 25' 10 1/2"



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TO COMMENCE LOADING DATE 12 JAN 1975		DRAFT FWD 9' 0"		DRAFT AFT 18' 08"		MEAN 13' 10"		VESSEL SS BLUNIT		LOADED BY MOTBA OAKLAND		LOADING LOCATION MOTBA PIER 7		DESTINATION CAM RANH BAY RVN	
ESTIMATED TO COMPLETE LOADING DATE 17 JAN 1975		DRAFT FWD 24' 3"		DRAFT AFT 28' 03"		MEAN 26' 04"		1ST PORT CAM RANH BAY		2ND PORT		3RD PORT		4TH PORT	

BOOMS 50-TON JUMBO AT #3 30-TON JUMBO AT #4 ALL OTHERS 5 TONS EACH	NINE (9) M37B1 3/4-TON 4x4 TRUCKS LT 24 CU FT 4,814 EIGHT (8) M35A2 2 1/2-TON 6x6 TRUCKS LT 49 CU FT 9,878	REMARKS ① ESTIMATED ARRIVAL DRAFTS RECEIVED FROM MSTs ② ESTIMATED SAILING DRAFT ON COMPLETION OF LOADING	EIGHT (8) M35A2 2 1/2-TON 6x6 TRUCKS LT 49 CU FT 9,878 NINE (9) M37B1 3/4-TON 4x4 TRUCKS LT 24 CU FT 4,814	
--	---	---	---	---

5	4	3	2	1	0
MEDICAL SUPPLIES LT 180 CU FT 15,120 DIESEL LT 494 CU FT 24,326	"C" RATIONS AG PUBLICATIONS CLOTHING PALLETIZED SUBSISTENCE MEDICAL SUPPLIES GENERAL LT 71 4,361 LT 55 3,190 LT 26 3,389 LT 411 24,803 LT 66 5,544 LT 70 2,920	"C" RATIONS PALLETIZED SUBSISTENCE GENERAL LT 50 3,244 LT 440 26,539 LT 210 11,227	"C" RATIONS PALLETIZED SUBSISTENCE GENERAL LT 43 2,665 LT 199 12,000 LT 175 9,350	FLOUR PALLETIZED SUBSISTENCE POWDERED EGGS GENERAL LT 49 2,303 LT 133 8,020 LT 89 1,629 LT 98 4,076	NAVY GENERAL LT 145 CU FT 8,830 AG PUBLICATIONS GENERAL LT 182 CU FT 10,556
AF GENERAL LT 87 CU FT 10,700 GENERAL LT 60 CU FT 5,820 DIESEL LT 84 CU FT 4,147 STEEL PLATE LT 175 CU FT 1,730	CLOTHING EIGHT (8) M35A2 2 1/2-TON 6x6 TRUCKS GENERAL "C" RATIONS STEEL PLATE LT 97 12,653 LT 49 9,878 LT 32 1,708 LT 275 16,913 LT 385 3,850	FLOUR "C" RATIONS PALLETIZED SUBSISTENCE STEEL PLATE LT 15 703 LT 224 13,778 LT 325 19,618 LT 25 250	MEDICAL SUP. GENERAL DIESEL LT 74 6,216 LT 13 1,261 LT 250 12,365	POWDERED EGGS PX BEER LT 58 4,970 LT 373 20,376	
ENGINE SPACE OMITTED					
RECESS FUEL OIL FUEL OIL FUEL OIL		CLOTHING AG PUBLICATIONS M60A1 TANKS STEEL PLATE LT 100 13,028 LT 70 4,060 LT 349 26,954 LT 325 3,250		GENERAL DIESEL STEEL PLATE LT 197 19,169 LT 94 4,634 LT 140 1,400	

1ST PORT 1,104 LT 1,666.4 M/T	1ST PORT 1,586 LT 2,477.1 M/T	1ST PORT 2,182 LT 3,313.2 M/T	1ST PORT 1,209 LT 1,846.8 M/T	1ST PORT 1,139 LT 1,681.5 M/T	1ST PORT 7,220 LT 10,985 M/T
2ND PORT M/T	2ND PORT M/T	2ND PORT M/T	2ND PORT M/T	2ND PORT M/T	2ND PORT M/T
3RD PORT M/T	3RD PORT M/T	3RD PORT M/T	3RD PORT M/T	3RD PORT M/T	3RD PORT M/T
4TH PORT M/T	4TH PORT M/T	4TH PORT M/T	4TH PORT M/T	4TH PORT M/T	4TH PORT M/T
5TH PORT M/T	5TH PORT M/T	5TH PORT M/T	5TH PORT M/T	5TH PORT M/T	5TH PORT M/T
6TH PORT M/T	6TH PORT M/T	6TH PORT M/T	6TH PORT M/T	6TH PORT M/T	6TH PORT M/T
7TH PORT M/T	7TH PORT M/T	7TH PORT M/T	7TH PORT M/T	7TH PORT M/T	7TH PORT M/T
8TH PORT M/T	8TH PORT M/T	8TH PORT M/T	8TH PORT M/T	8TH PORT M/T	8TH PORT M/T
TOTAL 1,104 LT 1,666.4 M/T	TOTAL 1,586 LT 2,477.1 M/T	TOTAL 2,182 LT 3,313.2 M/T	TOTAL 1,209 LT 1,846.8 M/T	TOTAL 1,139 LT 1,681.5 M/T	TOTAL 7,220 LT 10,985 M/T

Figure 2-23. Prestowage plan.

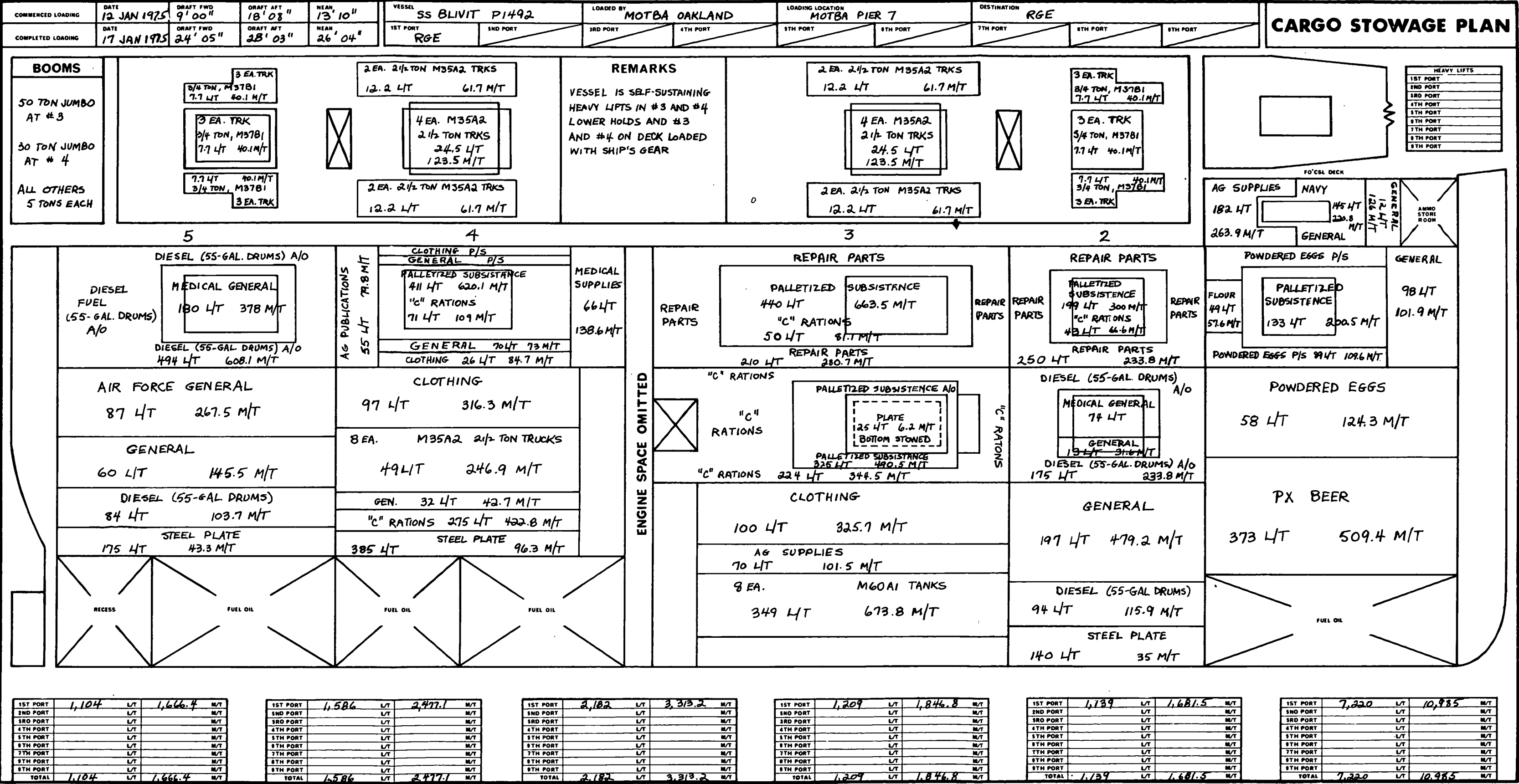


Figure 2-24. Final stowage plan.

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